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PHYSICS.—*Preliminary report: Nonlinear absorption and dispersion of plane ultrasonic waves in pure fluids.* C. TRUESDELL,[1] Graduate Institute for Applied Mathematics, Indiana University.

Wang Chang and Uhlenbeck (1, 2) have insisted, arguing from an expansion in powers of the ratio mean free path/wavelength, that the Navier-Stokes equations can not yield "a consistent theory" of nonlinear absorption and dispersion. They have claimed that for a monatomic gas the higher order stress and heat flux terms of Burnett and Chapman-Cowling must be employed to obtain correctly any dispersion at all and that to obtain correctly an absorption coefficient per wave'ength which is a nonlinear function of frequency one must consider even higher order stresses and heat flux. Following in the footsteps of numerous predecessors, they have given the first two terms in power series expansions for the absorption and dispersion coefficients. Their mean free path argument is hardly plausible: the Navier-Stokes equations are valid also in liquids; measured absorption and dispersion in liquids is very similar qualitatively to that in gases, yet for liquids mean free path arguments are quite inapplicable. That the Navier-Stokes equations are derived by Enskog's method of integration in the kinetic theory of monatomic gases only as a low order approximation does not prove they may *not* be derived under weaker assumptions by a better method from a more general kinetic theory including liquids as well as gases: indeed, in she past an equation has often been shown to be much better than some methods of deriving it might suggest.

Greenspan (3, 4) has recently published results of experiments on rarefied helium which give some support to this view. He has compared the measured values of the absorption coefficient with those predicted from four theoretical curves. In the region where these four curves diverge widely from one another, he finds that Wang Chang and Uhlenbeck's 2-term approximation based on as yet unpublished higher kinetic theory approximations is the worst of all; next comes the 2-term approximation from the Navier-Stokes equations; next the classical linearization of Kirchhoff; while the *exact* solution of the linearized Navier-Stokes equations fits perfectly. Discarding the 2-term expressions altogether, he then employs the exact results from the Navier-Stokes equations and the exact results from the kinetic theory expressions of Burnett and Chapman-Cowling; again he finds that the results from the Navier-Stokes equations agree markedly better with experimental values of the absorption coefficient, but the dispersion when $\gamma p/\omega\mu < 2$ is less than that predicted by either theory.

The foregoing results suggest that the exact consequences of the Navier-Stokes equations deserve a hearing. Greenspan's theoretical curves are limited to the case $\gamma = 5/3$, $\mathcal{P} = 2/3$, $\mathcal{U} = 4/3$, where $\mathcal{P} \equiv \mu c_p/\kappa$ is the Prandtl number and $\mathcal{U} \equiv 2 + \lambda/\mu$ is a number representing the relative magnitudes of the two viscosity coefficients λ and μ. I have thought it worth while to investigate the exact results for the entire range of values of γ, $\mathcal{P}$, and $\mathcal{U}$ which are experimentally measured in fluids, especially with a view to correct experimental determination of $\mathcal{U}$. For a pure fluid in which radiation is negligible the whole theory is contained in the characteristic equation derived for perfect gases by Kirchhoff (*5*) and extended to arbitrary pure fluids by Langevin (*6*):

[1] This work was done under Navy Contract N60nr-180, Task Order No. V, with Indiana University.

$$\left(\frac{\sigma}{2\pi}\right)^4\left[-\frac{\gamma\mathfrak{V}^2\mathcal{S}^2}{\mathcal{P}\mathfrak{V}}+i\frac{\mathcal{S}\mathfrak{V}}{\mathcal{P}\mathfrak{V}}\right]+\left(\frac{\sigma}{2\pi}\right)^2\left[1+i\,\mathcal{S}\mathfrak{V}\left(1+\frac{\gamma}{\mathcal{P}\mathfrak{V}}\right)\right]+1=0. \quad (1)$$

Here

$$\mathcal{S}\equiv\frac{\mu\omega}{\rho V_0^2},\qquad V_0^2\equiv\left(\frac{\partial p}{\partial\rho}\right)_\eta,$$

η being the specific entropy. Since $\mathcal{S}$ was introduced by Stokes, I call it the *Stokes number*. If σ be a solution of (1) then the corresponding absorption coefficient per reference wavelength $l_0 \equiv 2\pi V_0/\omega$ is $A_0 \equiv |\Re\sigma|$; the true absorption coefficient per wavelength $l \equiv 2\pi V/\omega$ is $A \equiv 2\pi|\Re\sigma/\Im\sigma|$; the speed of propagation V is given by $V/V_0 = 2\pi/|\Im\sigma|$. Convenient for theoretical work is the ratio $\mathfrak{A} \equiv A/(V/V_0)^2 = |\Re\sigma\Im\sigma|/2\pi$.

From (1) it follows that the entire phenomenon is governed by three scaling parameters, which we may choose as follows: $\mathfrak{X} \equiv \mathcal{S}\mathfrak{V}$, $\mathfrak{d} \equiv (\gamma - 1)/\mathcal{P}\mathfrak{V}$, γ. In special cases this number is reduced to $\mathfrak{X}$ and $\mathfrak{d}$ or even to $\mathfrak{X}$ alone. Since for a perfect gas $\mathfrak{X} = \mu\omega/[\gamma p(2 + \lambda/\mu)]$, it is plain that for absorption and dispersion in such a gas increase in frequency has the same scale effect as decrease in pressure.

The simplest case is that of a piezotropic fluid: $p = p(\rho)$. Here $\gamma = 1$ and equation (1) factors; the resulting exact coefficients for that one of the two pairs of solutions of (1) that represents a sound wave was given in a different form by Lamb (*7*), but his results are marred by an error in calculation. They should be amended to read

$$\left(\frac{V}{V_0}\right)^2=\frac{2(1+\mathfrak{X}^2)}{1+\sqrt{1+\mathfrak{X}^2}},\qquad \mathfrak{A}=\frac{\pi\mathfrak{X}}{1+\mathfrak{X}^2}; \quad (2)$$

thus $V \to \infty$ monotonically as $\mathfrak{X} \to \infty$, while $\mathfrak{A}$ experiences a single maximum $\mathfrak{A} = \pi/2$ when $\mathfrak{X} = 1$, falling off thereafter to zero. One may show that the curve of A_0 is similar to that for $\mathfrak{A}$, except that the maximum value $A_0 = \pi/\sqrt{2}$ occurs when $\mathfrak{X} = \sqrt{3}$. However, $A \to \infty$ monotonically as $\mathfrak{X} \to \infty$.

It is interesting to compare these results formally with those of Kneser (*8*, *9*, *10*) for absorption and dispersion arising from the internal degrees of freedom in gases. Taking account of van Itterbeck and Mariens's experimental evidence (*11*) that Kneser's relaxation time is inversely proportional to pressure, we may put Kneser's results into the present notation. We then find that Kneser's formula for $\mathfrak{A}$ becomes identical with $(2)_2$ except for numerical factors, but for $(V/V_0)^2$ Kneser obtains a finite limit $(V_\infty/V_0)^2$ as $\mathfrak{X} \to \infty$. The difference in the two dispersion formulae accounts also for the difference in the formulae for A_0 and A. From experimental data it is difficult to see even qualitatively which type of dispersion curve actually occurs. In any case the foregoing results show that to obtain an absorption peak it is not at all necessary to introduce molecular notions or to modify the Navier-Stokes equations. The "relaxation time" for A_0 according to (2) is $\tau = 2\pi(\lambda + 2\mu)/(\sqrt{3}\rho V_0^2)$.

The effect of the value of $\mathfrak{V}$ on absorption and dispersion is plain from (2). If $\mathfrak{A}$ or A_0 be regarded as functions of $\mathcal{S}$ for various fixed values of $\mathfrak{V}$, then increase in $\mathfrak{V}$ *increases* the initial slope (classical absorption coefficient) but *decreases* the value of $\mathcal{S}$ at which the absorption peak occurs. Thus liquids in which λ/μ is large show "relaxation" effects at much lower frequencies than if $\lambda/\mu = -2/3$, and their absorption peaks are sharper. Increase in the value of $\mathfrak{V}$ always increases the dispersion.

Now in the ultrasonic literature absorption measurements in liquids are always compared with the "classical" value $A = A_0 = \mathfrak{A} = (4/3)\pi\mathcal{S}$ obtained by linearizing $(2)_2$ and putting $\mathfrak{V} = 4/3$. The correct linearized expression, allowing for bulk viscosity, is $A = \pi\mathfrak{V}\mathcal{S}$. If, as has been suggested (*12*, *13*), $\mathfrak{V}$ is to be determined from this formula then *care must be taken that all results are extrapolated to* $\mathcal{S} = 0$. For otherwise the nonlinearity of $(2)_2$ needs to be taken into account, *especially if* $\mathfrak{V}$ *is large*. It is possible to get apparent agreement with the "classical" result by making two compensating errors: taking *too large* a value for A by linearizing $(2)_2$, but *too small* a value by assigning to $\mathfrak{V}$ its minimum, 4/3.

While the piezotropic fluid serves as a first approximation to a nonmetallic liquid,

a better approximation is obtained by supposing $\gamma \neq 1$ but $\gamma/\mathcal{P} << 1$. For the pair of solutions of (1) which as $\gamma \to 1$ approach those appropriate to sound waves in the piezotropic case, one may show that with great accuracy the following approximate formulae hold *for all values of* $\mathfrak{X}$:

$$\left(\frac{V}{V_0}\right)^2 = \frac{2(1+\mathfrak{X}^2)}{1+\sqrt{1+\mathfrak{X}^2}} \cdot \left[1 + \mathcal{S}\,\frac{3+2\sqrt{1+\mathfrak{X}^2}-\mathfrak{X}^2}{(1+\mathfrak{X}^2)^2(1+\sqrt{1+\mathfrak{X}^2})}\right], \tag{3}$$

$$\mathfrak{A} = \frac{\pi\mathfrak{X}}{1+\mathfrak{X}^2}\left[1 + \mathcal{S}\,\frac{1-3\mathfrak{X}^2}{(1+\mathfrak{X}^2)^2}\right]. \tag{4}$$

Comparison with (2) shows that a relatively slight amount of heat conduction slightly *increases* both absorption and dispersion for small $\mathfrak{X}$, but slightly *decreases* both for large $\mathfrak{X}$. In particular, the absorption peak is both *lowered* and *brought in* to a smaller value of $\mathfrak{X}$, for we have the maximum value $\mathfrak{A} = (\pi/2)(1 - \mathcal{Z}/2)$ when $\mathfrak{X} = 1 - \mathcal{Z}/2$. If the experimentally measured peak in $\mathfrak{A}$ can be accurately located, we have an excellent means of determining λ from the formula $\mathcal{U}\mathcal{S} = 1 - \mathcal{Z}/2$, or, approximately,

$$\frac{\lambda}{\mu} = -2 + \frac{1}{\mathcal{S}_m} - \frac{\gamma - 1}{2\mathcal{P}},$$

where $\mathcal{S}_m$ is the value of $\mathcal{S}$ at which resonance occurs. We have $\mathcal{S}_m \leqq 3/4$ always, since $\mathcal{S}_m = 3/4$, $\gamma = 1$ implies the Stokes relation $3\lambda + 2\mu = 0$, which gives λ its minimum value.

For gases it is possible to exhibit the exact coefficients but very difficult to trace their behavior as functions of $\mathcal{S}$.

The second pair of solutions of (1), which when $\gamma \to 1$ approach those appropriate to a thermal wave in a piezotropic fluid, yield a second type of waves, which if $\gamma \neq 1$ are unavoidably produced along with the first by any source of disturbance. These have been discarded by Kirchhoff and all subsequent investigators because as $\mathcal{S} \to 0$ they are much more strongly absorbed than the first. It is interesting to compare the two absorption coefficients for general values of $\mathcal{S}$. My results are not yet complete, but from (1) it is easy to see that as $\mathcal{S} \to \infty$ the two pairs of solutions approach those which would belong to a fluid in which $p = p(\rho)$ but formally $\gamma \neq 1$. Perhaps the ratio of their values in general is not too far different from that for such a fictitious fluid. Denoting the absorption coefficient for the second by $\bar{A}_0$, we have then $\bar{A}_0^2 = 2\pi^2\,\mathcal{P}/\gamma\mathcal{S}$,

$$\left(\frac{A_0}{\bar{A}_0}\right)^2 = \frac{\mathcal{P}(1+\mathcal{S}^2\mathcal{U}^2)}{\gamma\mathcal{S}[\sqrt{1+\mathcal{S}^2\mathcal{U}^2}-1]}.$$

This function is a monotone *decreasing* function of $\mathcal{S}$. Hence *as* $\mathcal{S}$ *grows larger, the possibility of observing the second type of wave increases.* As $\mathcal{S} \to \infty$ we have $\bar{A}_0^2/A_0^2 \to \mathcal{P}\mathcal{U}/\gamma$ (and this result is valid without approximation for the fully general eq. (1)). Hence *in nonmetallic liquids, where* $\mathcal{P}$ *is large, the second type of wave will never be observed at any frequency; in monatomic gases, however, since* $\mathcal{P}\mathcal{U}/\gamma = 8/15$, *at high frequencies and very low pressures the second type of wave is absorbed only about half as much as the former; while in metallic liquids, where* $\mathcal{P}$ *is small, the second type of wave will altogether predominate for large values of* $\mathcal{S}$, *unless perchance* $\mathcal{U}$ *be large.*

In a memoir now in preparation I shall give accurate graphs of all coefficients for $0 \leqq \mathfrak{X} \leqq 4$ and for all values of the parameters γ and $\mathcal{Z}$ which are found in actual fluids. I shall also attempt to compare these results with experimental data and thence, in particular, to determine reliable values for $\mathcal{U}$ in common pure fluids

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MINERALOGY.—*The nature of rock phosphates, teeth, and bones.* DUNCAN MCCONNELL, Ohio State University, Columbus, Ohio. (Communicated by W. F. Foshag.)

In order to understand the chemistry of rock phosphates it is essential to realize what minerals are likely to be present in these rocks (*1*). One must consider also that very few minerals have rigorously fixed compositions because they are subject to isomorphic variations. For example, one of the commonest mineral substances, plagioclase feldspar, may be a sodium aluminum silicate (albite) or a calcium aluminum silicate (anorthite), but the commonest varieties are intermediate in composition. When considering the chemical analysis of an intermediate variety of plagioclase, it is usually not possible to set down a simple formula, but one can indicate, nevertheless, the relative percentages of $NaAlSi_3O_8$ and $CaAl_2Si_2O_8$, which are the theoretical end members of the isomorphic series. If one attempts to calculate from the chemical analysis of a rock the amount and variety of feldspar present, he faces an impossible task if other mineral constituents containing Na_2O, CaO, and SiO_2 also are present and their amounts and compositions likewise are unknown.

The situation is similar when considering rock phosphates; the composition of the principal mineral constituent cannot be determined from the analysis of the rock unless the kinds and quantities of other minerals present can be determined accurately. Therefore, it becomes impossible to ascertain the types of isomorphic variation of the minerals, francolite, dahllite, etc., from even the most precise data obtained on heterogeneous substances such as phosporites.

The "mineral phase" of tooth and bone has been shown to be an apatitelike substance and, to this extent, it is similar to phosphorite. It differs from most phosphorites, however, in its low fluorine content. The substance of tooth and bone is not composed entirely of this apatitelike substance; it contains organic compounds in addition. Were it possible to remove the organic substances without in any way altering the inorganic material, it would be possible to study the crystal chemistry of the "mineral phase." Insofar as present knowledge is concerned, one of the important constituents of the "mineral phase" may be water (*2*), which occurs in combined form in the crystallites. No method that will remove the organic matter from teeth and bones without danger of altering the water content of the apatitelike substance has ever been described. Here again is the same situation: neither the kinds nor quantities of the other constituents are known. Therefore, quantitative study of the isomorphic variation of the apatite phase cannot be accomplished by experimentation on the whole substance of teeth and bones.

The exceedingly important difference between the chemical compositions of ordinary fluorapatite and the substances of teeth, bones, and phosphorites is the universal presence of significant amounts of carbon dioxide in the latter substances. Therefore, considerable interest has arisen in pure mineral substances which contain carbon dioxide and produce diffraction patterns similar to fluorapatite. Francolite is the best known of these substances; it occurs at several widely separated localities, but remarkable similarities between samples from Germany (*3*) and South Africa (*4*) exist. The mineral dahllite is similar to francolite except that it contains less than one percent fluorine (*5*). Lewistonite and dehrnite are similar in that they may contain carbon dioxide but are different to the extent that they contain potassium and sodium, respectively.

Details concerning the isomorphic substitutions which can occur in the apatite

lattice need not be considered here. Substitutions for calcium include K, Na, Mn, Mg, Sr, and Ba. Substitutions for phosphorus include Si, S, V, Cr, and probably aluminum. Such compounds as $Ca_{10}(OH)_2(SiO_4)_3(SO_4)_3$ and $(Na_6Ca_4)F_2(SO_4)_6$ clearly indicate the extensive possibilities for isomorphic substitution (*6*, *7*). Recognizing this extensive tolerance of the apatite structure for isomorphic substitution, one can return to the question of the sorts of isomorphic substitution in francolite.

In viewing the chemical nature of francolite, five recent analyses by well-qualified analysts are available. One quickly discovers that the Ca:P:C ratios are not uniform. This fact is no more surprising, however, than the fact that the ratios Na:Ca:Al of plagioclase feldspar are not constant. Nevertheless, the compounds $Ca_{10}CO_3(PO_4)_6$ has been assumed as a theoretical end member for the purpose of calculating the composition of dental enamel, and these calculations have been made within the past few years, completely disregarding the fact that Gruner and McConnell (*3*) disproved the existence of this compound in 1937.

The variation in Ca:P:C has been taken to indicate that francolite is composed of two phases. Although this conclusion by no means follows as a logical sequence to the principles of isomorphism, one might ask whether or not any other evidences for the presence of two phases exist. In view of the water-clear condition of the francolite crystals, the proponents of the 2-phase hypothesis are forced to call upon "submicroscopic" or "colloidal" particles of $CaCO_3$ distributed throughout the francolite. This explanation is unique in its application to francolite, and several incompatabilities arise from consideration of the data. If francolite were composed of fluorapatite and $CaCO_3$, one could obtain the correct stoichiometry for fluorapatite merely by deducting equivalents of CaO and CO_2 from the analyses of francolite. This is by no means the case, however, and the discrepancies which occur probably exceed the experimental error in each instance (*2*).

Far more important, however, is the fact that the unit-cell dimensions of francolite and fluorapatite differ by amounts which far exceed the experimental error for these measurements (*2*). X-ray diffraction data obtained by use of the Philips high-angle spectrometer indicate, furthermore, that significant intensity differences also exist. In the absence of any explanation of how the so-called colloidal particles of $CaCO_3$ could possibly alter the diffraction pattern of apatite in this way, it becomes necessary to conclude that the crystal lattice of francolite is somewhat different from that of the fluorapatite and these differences are the cause of the X-ray diffraction phenomena.

Recently, Hendricks and Hill (*8*) have obtained an explanation based upon absorption of nitrogen by francolite. They conclude that certain surfaces exist within francolite crystals and that these "discontinuities" are capable of adsorbing carbonate. The physical analogy is not quite clear but apparently the "carbonate" is believed to be present in the form of ions which are brought to electrical neutrality by cations in the structural arrangement. Further scrutiny will indicate that they postulate a new type of disordering in crystals in which part of the atoms are in the lattice and part are present at discontinuities. One can not predict how such a process could be detected by crystallographic methods, and Hendricks and Hill do not clarify the matter, but here again is a hypothesis that seems to have francolite as an unique example.

It is noticeable that they calculate 61 $m.^2/g.$ as the "surface" of francolite whereas the highest experimental value is 7.3 $m.^2/g.$ and no comment appears in explanation of this significant discrepancy. One can extend their method of calculation in order to obtain the periodicity of interruption of a solid system with regular 3-dimensional coordinates. Under these circumstances, the average spacing of the discontinuities would be 315 Å. What the effect of discontinuities of this spacing would be on the X-ray diffraction pattern is difficult to predict without a more reliable knowledge of the true nature of these discontinuities. Nevertheless, it can be assumed that such a condition would not merely alter the spacings and intensities without in any way altering the excellency of resolution of the diffraction lines. In this

connection it is noteworthy that although bone produces broad and diffuse diffraction lines, the lines of francolite are essentially as sharp and distinct as those of fluorapatite (*2*).

Quite in contrast with some of the explanations discussed above, stand attempts to seek an explanation of the crystal lattice of francolite in terms of the principles of isomorphic substitution. That knowledge of all of these principles is not presently available can safely be admitted. Nevertheless, it is possible through slight extension of well recognized principles to obtain a structural model which has two important properties (*2*). It is capable of qualitative alteration of the intensities of prismatic diffraction maxima as well as the birefringence. Both values are observed to increase for francolite when compared with fluorapatite. Quantitative comparisons cannot be obtained readily because of limitations imposed by an inexact knowledge of the precise atomic coordinates for pure apatite. No reliable integrated intensity measurements for an analyzed sample of apatite have been published and therefore the published coordinates cannot claim great precision.

Although Bale (*9*) claims to have refined the coordinates for one type of calcium position by small percentages of the cell edge, his crystal of apatite apparently was not analyzed, so his results are quite meaningless. Beevers and McIntyre (*10*) stated that they were able to obtain highly refined coordinates for the atoms in apatite but neither did they give their newly determined coordinates nor did they indicate that analyzed material was used. Their principal contribution, consequently, was a series of colored diagrams which explain the well known structures proposed by Náray-Szabó (*11*) and by Mehmel (*12*).

Properties of francolite other than those which can be measured by X-ray diffraction should also be mentioned briefly. The birefringence of francolite exceeds that of fluorapatite (*13*), francolite is usually biaxial and may have an optic angle as large as 40° (*14*, *15*), and the mean refractive index of francolite is less than that of fluorapatite (*13*). In summary on the properties of francolite, one concludes that all the crystallographic properties are different from those of fluorapatite and that adsorption or the presence of colloidal impurities apparently are incapable of explaining these differences.

Returning to teeth, bones, and phosphorite one concludes: (1) The physical and chemical properties of these substances are largely dependent upon the properties of francolite or dahllite, and (2) the properties of these heterogeneous substances cannot be expected to reveal the isomorphic nature of francolite or dahllite. Concerning francolite these additional conclusions obtain: (3) Direct study of the chemical and physical properties has resulted in an explanation of the crystal structure of francolite which appears to be consistent qualitatively with all of the observed data, (4) quantitative confirmation of the proposed structure for francolite will require additional data, which will be difficultly obtainable for several reasons, and (5) the assumption of adsorptive processes or mechanical admixtures will not account for the experimental data on francolite.

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BOTANY.—*Notes on some families of Formosan phanerogams.* HUI-LIN LI, National Taiwan University, Taipeh, Taiwan, China. (Communicated by A. C. Smith.)

These notes are the result of critical studies on selected families of Formosan flowering plants, namely, Juglandaceae, Ulmaceae, Lardizabalaceae, Beberidaceae, and Saxifragaceae. Most of the species of plants described from this island by botanists have been proposed without adequate consideration of the neighboring and closely related floras, except for that of Japan. We now realize that the flora of Formosa is more closely related to the flora of mainland China than to that of any other region; numerous mainland species are represented in Formosa by their typical form or by a variation. Both the lowland and the montane floras of the island show intimate kinship with those of the mainland, the relationship in the former case being especially with southern China and in the latter case particularly with the highlands of western China. The flora of Formosa also shows close relationships with that of the Philippine Islands, especially as regards the southern species and to a certain extent also the montane species. In order properly to interpret the identity, nature, and range of Formosan species, it is therefore essential to consult closely all the neighboring floras.

Large series of specimens from mainland China, Hainan, the Philippines, the Liukius, and Japan now being available to the present writer, careful studies of selected families of Formosan plants show that considerable alterations in our concept of some species are necessary. In the present paper, three new species, one new variety, and one new form are proposed, three new combinations are effected, and one new record is indicated. Twelve names are found to represent synonyms of previously described species and reductions are accordingly made. Several binomials, relegated to synonymy by former authors, are reinstated as distinct entities. These findings will serve to indicate what we may expect as we review the Formosan flora in particular and the eastern Asiatic flora in general.

The materials used are those of the herbarium of the National Taiwan University (indicated as NTU) and the U. S. National Herbarium (US). Only selected specimens are cited from the former herbarium.

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Engelhardtia chrysolepis Hance in Ann. Sci. Nat. IV. **15**: 227. 1861.

Engelhardtia formosana Hay. Icon. Pl. Formos. **6**: 61. 1916; Kanehira, Formos. Trees rev. ed. 80. *f. 36*. 1936. *Syn. nov.*

Engelhardtia spicata Blume var. *formosana* Hay. in Journ. Coll. Sci. Tokyo **25** (19): 199. 1908 (Fl. Mont. Formos.). *Syn. nov.*

FORMOSA: Mount Noko, *H. H. Bartlett 6158* (US); Baibara Nokogun, *S. Sasaki* Aug. 27, 1924 (NTU).

Southern China. In Formosa, common in broad-leaved forests throughout the island.

The Formosan plant is identical with the mainland species, which is widely distributed from northern India through western to southern China. The species shows some variation. When herbarium specimens from various regions are compared, the Formosan ones are similar particularly to those from Hainan Island.

Juglans cathayensis Dode in Bull. Soc. Dendr. France 1909: 47. *f.* 1909.

Juglans formosana Hay. in Journ. Coll. Sci. Tokyo **30** (1): 283. 1911 (Mat. Fl. Formos.); Kanehira, Formos. Trees rev. ed. 82. *f. 36*. 1936. *Syn. nov.*

FORMOSA: Kaunko, Kwarenko, *E. H. Wilson 11152* (US).

Widely distributed in China. In Formosa, scattered in forests at 1,200–2,000 meters.

Hayata originally described the Formosan plant as a distinct species and compared it with

J. cordiformis Maxim. and *J. sieboldiana* Maxim. of Japan. Actually the plant is identical with *J. cathayensis* Dode, a species of wide distribution on the Chinese mainland, and the two are evidently conspecific.

Platycarya strobilacea Sieb. & Zucc. in Abh Math.-Phys. Kl. Akad. Wiss. Münch. **3**: 741. 1843.

Platycarya strobilacea var. *kawakamii* Hay. in Journ. Coll. Sci. Tokyo **30** (1): 284. 1911 (Mat. Fl. Formos.). *Syn. nov.*

Petrophiloides strobilacea var. *kawakamii* (Hay.) Kanehira, Formos. Trees rev. ed. 82. *f. 37*. 1936.

China to Japan. In Formosa, in forests at medium altitudes in the northern part of the island.

FORMOSA: Seisui, Kwarenko, *Kanehira & Sasaki 7264* (US, photo).

Hayata proposed the Formosan entity as a variety, stating that it "Differs from the type in having much smaller leaflets, and narrower cones with a little broader bracts." These differences, shown by a single specimen, do not actually differentiate the Formosan plant as a distinct variety. It does not differ significantly from plants of the Chinese mainland and Japan, which exhibit considerable variation in all parts of the plant.

ULMACEAE

Trema virgata (Roxb.) Blume, Mus. Bot. Lugd.-Bat. **2**: 58. 1856; Hand.-Mazz. Symb. Sin. 7: 106. 1929.

Celtis virgata Roxb. in Wall. List n. 3694. 1828–49.

Southern China. New record for Formosa.

FORMOSA: Sintin, Taihoku-syu, *K. Odashima 13605* (US).

Ulmus uyematsui Hay. Icon. Pl. Formos. **3**: 174. *pl. 32*. 1931; Kanehira, Formos. Trees rev. ed. 143. *f. 90*. 1936.

Endemic. In forests of the central mountains at altitudes of 1,500–2,000 meters.

FORMOSA: Arisan, *E. H. Wilson 9684* (US).

Ulmus uyematsui Hay. is apparently endemic to Formosa. Handel-Mazzetti (Symb. Sin. **7**: 100. 1931) doubtfully refers several collections from mainland China to this species. One of these, *Ching 2194a*, from southern Chekiang (US), is available. This specimen bears leaves that are distinctly cordate at base, densely appressed-pubescent beneath, simple serrate at margins, and with more than 20 lateral veins per side; it is very clearly distinct from *U. uyematsui*.

Zelkova serrata (Thunb.) Makino in Bot. Mag. Tokyo **17**: 13. 1903.

Zelkova formosana Hay. Icon. Pl. Formos. **9**: 104. *f. 33, 1 & 2*. 1920; Kanehira, Formos. Trees rev. ed. 144. *f. 91*. 1936. *Syn. nov.*

Eastern China to Japan. Formosa, in forests at about 1,000–2,000 meters.

FORMOSA: Musha, *E. H. Wilson 10102* (US); no locality, *Taiwan Univ. Herb.* (NTU).

Zelkova formosana was noted by both Hayata and Kanehira as very close to *Z. serrata*, differing only in the smaller leaves. However, the leaves of Formosan plants are about the size of the normal leaves of Japanese and Chinese plants, which sometimes may bear much larger ones on sprouting shoots. As there is no other single character to support its differentiation, *Z. formosana* is here reduced to the synonymy of *Z. serrata*.

Zelkova serrata (Thunb.) Makino var. **tarokoensis** (Hay.) comb. nov.

Zelkova tarokoensis Hay. Icon. Pl. Formos. **9**: 104. *f. 33, 3 & 4*. 1920.

Endemic to the eastern coast of Formosa.

FORMOSA: Taitotyo, Sinkogun, *T. Suzuki 19728* (NTU).

Kanehira (loc. cit.) treated this entity as a straight synonym of *A. formosana* (= *Z. serrata*) but noted its small leaves with fewer veins. The leaves are also much less sharply serrate and are totally glabrous. It appears as a distinct but very localized variety.

LARDIZABALACEAE

Stauntonia hexaphylla (Thunb.) Decaisne f. **rotundata** Wu in Notizbl. Bot. Gart. Berlin **13**: 369. 1936.

Stauntonia obovatifoliolata Hay. Icon. Pl. Formos. **8**: 4. *f. 3, 1–6*. 1919; Kanehira, Formos. Trees rev. ed. 180. 1936. *Syn. nov.*

Japan, Liukiu. Formosa, in central mountains.

FORMOSA: Musya, Nanto, *T. Kawakami 9882* (US, photo).

Wu, without seeing the type, reduced *S. obovatifoliolata* together with *S. obovatifoliolata* var. *penninervis* Hay. to the synonymy of *S. hexaphylla* f. *obovata* Wu. Photographs of Hayata's types show that the two are different and the former should be referred instead to f. *rotundata*.

Stauntonia hexaphylla (Thunb.) Decaisne f. **cordata** f. nov.

A typo speciei foliolis distincte cordatis differt; foliolis ovato-oblongis vel oblongo-lanceolatis, 5–7.5 cm longis, 2–2.7 cm latis, apice caudato-acutis, basi distincte cordatis.

Formosa, in forests between Yappitu and Dozan, Taihoku-syu, *T. Suzuki 8751*, April 17, 1933 (NTU, type).

Stauntonia obovata Hemsley in Hook. Icon. Pl. **29**: *pl. 2847*. 1907.

Stauntonia hebandra Hay. Icon. Pl. Formos. **8**: 3. *f. 2*. 1919; Kanehira, Formos. Trees rev. ed. 180. 1936; Wu in Notizbl. Bot. Gart. Berlin **13**: 375. 1936. *Syn. nov.*

Southern China to Formosa.

FORMOSA: Karapin and Funkiko, *B. Hayata 9875* (US, photo of isotype).

Hayata differentiated his species from *S. obovata* Hemsley by the obtuse or emarginate anthers. In *S. obovata* the anthers are very shortly apiculate, the spur attaining a length of hardly 1 mm. Hayata's illustration shows that the anthers of his plant vary from nonapiculate to shortly but distinctly apiculate. Undoubtedly the Formosan plant is conspecific with the Chinese mainland species.

Stauntonia obovata Hemsley var. **angustata** (Wu) comb. nov.

Stauntonia hebandra Hay. var. *angustata* Wu in Notizbl. Bot. Gart. Berlin **13**: 375. 1936.

Endemic, common in thickets of central mountains.

FORMOSA: Horisha, Nanto, *E. H. Wilson 9949* (US, isotype).

BERBERIDACEAE

Mahonia morrisonensis Takeda in Notes Bot. Gard. Edinb. **6**: 239. *pl. 36, f. 200–206*. 1917.

Endemic to Formosa, in forests on central ranges, rare, at about 2,500 meters.

FORMOSA: Matsuyama, prov. Kagi, *E. H. Wilson 9816* (US).

Kanehira (Formos. Trees rev. ed. 184. 1936) reduced *M. morrisonensis* Takeda to the synonymy of *M. oiwakensis* Hay., as a result of his examination of the types. However, a photograph of Takeda's isotype (*Kawakami & Mori 9941*, US), although showing only a few leaves, definitely indicates that the plant is distinct from Hayata's species. It is readily distinguished by the fewer leaflets, which are larger, much broader, more falcate in shape, and with more teeth on the margins. The terminal leaflet, instead of being the largest one as in *M. japonica* and *M. oiwakensis*, is among the smallest.

Takeda mentioned at the same time a specimen collected by U. Mori on Mount Morrison, which he left undetermined, as having about twelve pairs of leaflets which are thicker, hardly falcate, and with less numerous teeth; he believed it might represent a new species. These characters, however, clearly demonstrate that the specimen in question belongs to *M. oiwakensis* Hay.

Berberis formosana sp. nov.

Frutex parvus; ramulis novellis gracilibus, leviter cinereis, angularibus, conspicue sulcatis; foliis spinescentibus 2- vel 3-aristatis, spinis 1–1.5 cm longis; foliis normalis 2- vel 3-verticillatis, chartaceis, brevi-petiolatis, oblongo-lanceolatis, 1.5–3 cm longis, 0.6–1.2 cm latis, apice acutis vel mucronulato-apiculatis, basi acutis vel obtusis, margine subintegris vel spinoso-serratis, spinis utrinsecus ad 6, gracilibus, ad 1 mm longis, adpresso-adscendentibus, utrinque glabris, supra viridibus vel leviter glaucis, subtus leviter atris plus minusve nitidis, costa supra impressa subtus valde elevata, venis secundariis utrinsecus 5–7, supra inconspicuis, subtus leviter elevatis, ad marginem distincte anastomosantibus; petiolis haud 1.5 mm longis; floribus ignotis; fructibus immaturis 2–6-fasciculatis, ovoideis, ad 4 mm longis et 2 mm crassis, atro-cyanis, distincte glaucis, apice stigmatibus coronatis.

FORMOSA: Mountains near Muroroahu, Taihoku-syu, *T. Suzuki 7258*, July 17, 1932 (NTU, type).

This distinct species has chartaceous leaves like those of *B. morrisonensis* Hay., but it is readily distinguished by the shape of the leaves and the inconspicuous venation. It also has more fruits and these are elongated. It is a moss-clad plant of the high mountains, with slender branches. In its leaves, which have a pale subglaucous upper surface and a dark more or less shining lower surface, it is very different from all other Formosan species of the genus.

Berberis alpicola C. Schneider in Rep. Sp. Nov. **46**: 253. 1931.

Endemic in Formosa, common on Mount Arisan at stream-sides at 3,600 meters.

FORMOSA: Arisan, *E. H. Wilson 10952* (US, isotype).

This species is characterized by its small shining leaves with strong spreading spines at the margins. It is apparently very close to *B. kawakamii* Hay., as the type collection was first identified by Byhouwer (in Journ. Arnold Arb. **9**: 133. 1928) as representing that species. Yojira Kimura, in Journ. Jap. Bot. **16**: 58. 1940, considered *B. alpicola* (as "*alpicora*") Schneider as a synonym of *B. morrisonensis* Hay., basing his conclusion on the original description. This placement is erroneous, as the type collection shows *B. alpicola* to be very different from the rather distinct *B. morrisonensis* Hay., although very close to *B. kawakamii* Hay.

Berberis brevisepala Hay. Icon. Pl. Formos. **3**: 14. 1913; Kanehira, Formos. Trees rev. ed. 182. 1936.

Berberis densifolia Byhouwer in Journ. Arnold Arb. **9**: 133. 1928; Kanehira, Formos. Trees rev. ed. 182. 1936; non Rusby. *Syn. nov.*

Berberis nantoensis C. Schneider in Rep. Sp. Nov. **46**: 252, 1939. *Syn. nov.*

Endemic to Formosa, high central mountains, over 3,500 meters.

FORMOSA: Mount Kiraishui, prov. Nanto, *E. H. Wilson 10074* (US, isotype of *B. densifolia* Byhouwer).

A photograph of the isotype of *B. brevisepala*, *U. Mori*, April 1910 (US, photo), is available. Hayata's original description does not discuss the flower or fruit. The flowers are 7- or 8-fasciculate, with pedicels about 1 cm. in length. The fruit is ovoid, to 9 mm long and 5 mm across, dark bluish black, and more or less glaucous. The densely leafy habit and the thickly coriaceous leaves with strongly recurved margins are very characteristic. *Berberis densifolia* Byhouwer, based on a smaller-leaved specimen, is apparently referable to this same species. Kanehira did not have access to the type, nor did he notice the name *B. nantoensis* C. Schneider given to this same plant.

SAXIFRAGACEAE

Hydrangea lobbii Maxim. in Mém. Acad. Sci. St. Pétersb. VII. **10**: 15. 1867.

Hydrangea macrosepala Hay. Icon. Pl. Formos. **3**: 108. 1913; Kanehira, Formos. Trees rev. ed. 244. *f. 187.* 1936. *Syn. nov.*

Philippine Islands. In Formosa, widely distributed in lower forests.

FORMOSA: Kotosho, *T. Hosokawa 9887* (NTU); *Kashoto, Y. Kudo & K. Mori 241* (NTU).

This species, widely distributed in Formosa and known as *H. macrosepala* Hay., is the same as *H. lobbii* Maxim., of wide distribution in the mountains of the Philippines. The obscurely denticulate leaves and the prominent sepals on the fruit are very characteristic.

Deutzia pulchra Vidal, Revis. Pl. Vasc. Filip. 124. 1886; Rehder in Sarg. Pl. Wils. **1**: 18. 1911; Turrill in Bot. Mag. **148**: *pl. 8962.* 1923; Kanehira, Formos. Trees rev. ed. 238. *f. 179.* 1936.

Deutzia taiwanensis Hay. in Journ. Coll. Sci. Tokyo **30** (1): 132. 1911. (Mat. Fl. Formos.); Hay. Icon. Pl. Formos. **1**: *pl. 33.* 1911, 2: 8. 1912; non Schneider.

Deutzia pulchra Vidal. var. *formosana* Nakai in Bot. Mag. Tokyo **35**: 84. 1921.

Deutzia hayatai Nakai in Bot. Mag. Tokyo **35**: 83. 1921.

Deutzia bartlettii Yamamoto, Suppl. Icon. Pl Formos. **4**: 16. *f. 10.* 1928.

Mountains of northern Luzon and Formosa.

FORMOSA: Mount Arisan, *E. H. Wilson 9742* (US); Parsha, prov. Giran, *E. H. Wilson 10126* (US); Mt. Noko, *H. H. Bartlett 6133* (US), *6244* (US), *Kanehira & Sasaki 21712* (US); Kando & Rikiki, Takao-syu, *T. Suzuki 7881* (NTU); Mt. Morrison, *H. H. Bartlett 6312* (US, isotype of *D. bartlettii* Yamamoto).

The Formosan plant is manifestly the same as the plant found in the mountains of northern Luzon. Rehder noted a slight difference in the number of rays of the stellate hairs when he compared a single specimen from Formosa with another from Luzon. Nakai considered the Luzon plant as having more acuminate leaves and the calyx-lobes "late ovati" instead of "late depresso-ovati." However, when the Formosan specimens are compared with a large series of Luzon plants, such differential characters seem inconsequential. Kanehira is thus correct in not recognizing the Formosan plant as a distinct variety. He also reduced *D. hayatai* Nakai, based on *Kawakami & Nakahara 988*, from Kotosho (Botel Tabago), which conclusion is similarly justified.

Deutzia cordatula sp. nov.

Frutex, ramulis tenuibus, angularibus, dense fulvo-tomentosis, tomento stellato; foliis chartaceis, ovatis, 4.5–8 cm longis 2–3.8 cm latis,

apice acutis, basi cordatulis, margine leviter scabridis, subtus pallidis, stellato-villosis, costa venisque dense fulvo-stellato-tomentosis, supra leviter impressis, subtus distincte elevatis, venis secundariis utrinsecus 5 vel 6, arcuato-adscendentibus, ad marginem anastomosantibus; petiolis brevibus haud 2 mm longis, stellato-tomentosis; inflorescentiis parvis paniculatis, ramulis terminalibus, ad 5.5 cm longis, dense fulvo-stellato-tomentosis; pedicellis 2–4 mm longis; calyce campanulato, tubo circiter 3 mm diametro, extus dense fulvo-stellato-tomentoso, lobis minutis, triangularibus, acutis; petalis oblongis, circiter 8 mm longis et 3–4 mm latis, subobtusis; staminibus 10, inequilateralibus, filamentis 5–7 mm longis; stylis 4, distinctis, 6–7 mm longis, apice dilatatis, indistincte 2-lobatis; ovario 4-loculari; ovulis numerosis.

FORMOSA: Mount Kwanonzan, Taihoku-syu, *N. Fukuyama & S. Miura 14*, April 29, 1940 (NTU, type).

This very distinct species is strongly characterized by the densely tomentose habit, the cordatulate, short-petiolate leaves, and the narrow, racemelike inflorescence. It suggests no close relationships with other species but perhaps can be remotely associated with *D. sieboldii* Koern., of Japan.

Itea parviflora Hemsley in Ann. Bot. **9**: 153. 1895; Kanehira, Formos. Trees rev. ed. 246. *f. 189*. 1936.

Considerable confusion exists concerning the classification of the genus *Itea* in Formosa. *Itea parviflora* Hemsley was described in 1895, from materials procured at the southern tip of the island. The species *I. chinensis* Hook. & Arnott was recorded by Henry in 1896, and later by Matsumura & Hayata and others from the northern part of the island. Hayata described *I. arisanensis* in 1916, basing it on materials from the central part of the island. In 1932 Masamune treated this as a variety of *I. chinensis*. In Kanehira's treatment of Formosan trees in 1936, he listed *I. chinensis*, *I. parviflora*, and *I. arisanensis* as present in Formosa. In 1937, Yamamoto made a special review of the genus in Formosa, listing *I. chinensis*, *I. parviflora*, and *I. arisanensis* and at the same time describing two varieties, var. *longifolia* and var. *parvifolia* under the last species. Migo, in 1944, considered *I. arisanensis* Hay. as a synonym of *I. chinensis*.

Apparently none of the Japanese authors has had a chance of examining isotypes of Henry's *I. parviflora*, and consequently this species was much misunderstood. Yamamoto emphasized the size of flowers and differentiated the three species by slight differences in floral diameter. This character actually is not constant, as flowers on the same plant may vary in their diameter according to age. Furthermore, the plant with coriaceous leaves found in northern Formosa is in reality different from *I. chinensis* of mainland China and is here proposed as a new species. Yamamoto's *I. arisanensis* var. *longifolia* is the same as the typical form of *I. parviflora* Hemsl. The type specimen of *I. parviflora* Hemsley shows slight tufts of hairs in the nerve-axils on the lower surface of the leaves, like the plant depicted by Yamamoto. His *I. arisanensis* var. *parvifolia*, showing a similar kind of hairs but with broader leaves, belongs to *I. parviflora* var. *latifolia* as here proposed. "*Itea parviflora*" of Yamamoto presumably also belongs here, although his drawing does not show the tufts of hairs in the nerve-axils, but these hairs are very few and thin and sometimes are not present in older leaves. The leaves of *I. arisanensis* are oblong and large and they have 7 or 8 nerves per side instead of 5 or 6 as described and depicted by Yamamoto. This entity was made into a variety of *I. chinensis* by Masamune, but it is a different plant from *I. chinensis* and the actual presence of the latter in Formosa is questionable *Itea arisanensis* is closely related to *I. parviflora* and is best treated as a variety.

The following key serves to differentiate the Formosan species and varieties of the genus *Itea:*

A. Leaves membranaceous, the margins entire to crenate-serrulate.
  B. Leaves lanceolate, 8–12 cm long, 2.5–3.5 cm broad; nerves 5 or 6.
    I. parviflora var. *parviflora*
  BB. Leaves ovate, 9–10 cm long, 4–5 cm broad; nerves 5 or 6. . . . . *I. parviflora* var. *latifolia*
  BBB. Leaves elliptic, 10–14 cm long, 3–5 cm broad; nerves 7 or 8.
    I. parviflora var. *arisanensis*
AA. Leaves coriaceous, ovate, the margins with few to several large teeth. . . . . *I. formosana*

Itea parviflora Hemsley var. **parviflora.**

Endemic in Formosa, widely distributed in forests.

FORMOSA: South Cape, *A. Henry 1322* (US, cotype coll.), *1980* (US); Bankensing, *A. Henry*

1486 (US); Gu-kutsu, Kwarenko, *E. H. Wilson 11069* (US); Sozan, Taihoku, *E. H. Wilson 10722* (US), *T. Tanaka & Y. Shimada 11040* (US).

Itea parviflora Hemsley var. **latifolia** var. nov.

Itea parviflora sensu Yamamoto in Acta Phytotax. Geob. **6**: 248. *f. 2.* 1937, non Hemsley.

Itea arisanensis var. *parvifolia* Yamamoto loc. cit. 248. *f. 3d.* 1937. *Syn. nov.*

A typo speciei differt foliis latioribus; foliis membranaceis, ovatis, 9–10 cm longis, 4–5 cm latis, apice acutis vel acuminatis, basi late acutis, margine creanato-serrulatis, nervis secundariis utrinsecus 5 vel 6.

Formosa: Bankensing, *A. Henry 550* (US 455805, type), *548* (US).

Itea parviflora Hemsley var. **arisanensis** (Hay.) comb. nov.

Itea arisanensis Hay. Icon. Pl. Formos. **6**: 19. 1916; Kanehira, Formos. Trees rev. ed. 246. 1936.

Itea chinensis var. *arisanensis* Masamune ex Kudo & Masamune, in Ann. Rep. Taihoku Bot. Gard. **2**: 117. 1932.

Formosa, central mountains at an altitude of about 1,300 meters.

Formosa: Mount Suibarai, Tikuto-gun, Sintiku-syu, *T. Suzuki 20232* (NTU).

Itea formosana sp. nov.

Itea chinensis sensu Henry in Trans. Asiat. Soc. Jap. 24. Suppl.: 41. 1896; Matsum. & Hay. in Journ. Coll. Sci. Tokyo **22**: 133. 1906; Hay. Icon. Pl. Formos. **2**: 10. 1912; Kudo & Masamune in Ann. Rep. Taihoku Bot. Gard. **2**: 117. 1932; Sasaki, List Pl. Formos. 208. 1928, Cat. Govern. Herb. (Formos.) 241. 1930; Makino & Nemoto, Fl. Jap. ed. 2. 292. 1932; Kanehira, Formos. Trees rev. ed. 245. *f. 188.* 1936; non Hook. & Arn.

Frutex 2–3 m altus; ramulis plus minusve crassis, novellis laxe pilosis; foliis coriaceis, glabris, ovatis vel ovato-oblongis, 6–9 cm longis, 4–5 cm latis, apice breviter acutis, acuminatis, vel obtusis, basi subobtusis vel acutis, margine remote pauci-dentatis, raro subintegris, dentibus utrinsecus ad 10, interdum ad apicem 2–3, triangularibus, acutis, ad 4–5 mm longis et 7–8 mm latis, costa supra impressa subtus valde elevata, venis secundariis utrinsecus 5–7, arcuato-adscendentibus; petiolis circiter 1 cm longis; inflorescentiis axillaribus vel terminalibus, racemosis, 3–5 cm longis, semper pubescentibus; pedicellis 2–4 mm longis patentibus; bracteis linearibus; calycis tubo infundibulari, 2 mm diametro, limbo 5-lobato, lobis triangularibus, 1.5 mm longis, extus pilosis; petalis 5, albidis, lanceolatis, circiter 2.5 mm longis et 1 mm latis, ad apicem costatis, intus glabris, extus pilosis; staminibus 5, quam petalis plus minusve longioribus, inferne pubescentibus; ovario urceolato, pubescente; fructibus urceolatis, 5–6 mm longis, basim 2 mm crassis, leviter pubescentibus, sepalis persistentibus coronatis, vel 2-carpellis dehiscentibus.

Formosa, in thickets, northern part of the island.

Formosa: Nanwo, prov. Kwarenko, *E. H. Wilson 11123* (US); Taihoku, *E. H. Wilson 9908* (US); Sozan, Taihoku-syu, *T. Kawakami*, Oct. 1912 (NTU); Sizangan, Taihoku-syu, *K. Mori*, Oct. 11, 1931 (NTU, type); Herinbi, Taihoku-syu, *E. H. Wilson 10259* (US); Tamsui, *R. Oldham 108* (US); Keelung, *T. Tanaka 346* (US).

Itea formosana differs from *I. chinensis*, of the mainland, in the much more coriaceous leaves, often with a few large broad teeth. In the serration it somewhat resembles *I. ilicifolia* Oliver, of western China, but the teeth are not so sharp and fine as in the latter species. The inflorescences are generally shorter and the flowers and fruits are smaller than those of *I. chinensis*.

Pilostegia viburnoides Hook. & Thoms. in Journ. Linn. Soc. **2**: 76. *pl. 2.* 1875.

Pilostegia viburnoides Hook. & Thoms. var. *parviflora* Oliver ex Maxim. in Mém. Acad. Sci. St. Pétersb. VII. **10** (16): 18. 1867.

Schizophragma viburnoides Stapf. in Bot. Mag. **155**: *pl. 9262.* 1931.

Pilostegia urceolata Hay. Icon. Pl. Formos. **3**: 105. 1913. *Syn. nov.*

Southern Japan, Liukiu Islands. In Formosa in central mountains at 1,200–2,500 meters.

Formosa: Arisan, *E. H. Wilson 9660* (US); Funkiko, prov. Kagi, *E. H. Wilson 10827* (US); Mt. Taiheisan, *H. H. Bartlett 6054* (US), *S. Suzuki 714* (NTU).

Only one species of *Pilostegia* is present in Formosa and this proves to be the same as that of southern Japan and the Liukiu Islands.

ENTOMOLOGY.—*New species of Sarcophagini (Diptera: Sarcophagidae).*[1] SELWYN S. ROBACK, University of Illinois. (Communicated by C. W. Sabrosky.)

The following descriptions of new species are based on material from several collections examined in the course of phylogenetic studies on the Sarcophaginae. The disposition of the types is indicated after each species description.

Sarcophaga hollandia, n. sp.
Fig. 1

Close to *Sarcophaga antilope* Böttcher and *S. piva* Roback but differs from these in the lack of the golden pollen on the body. Also related to *Sarcophaga beta* Johnston and Teigs, but differs in details of genital structure. The anterior lateral clasper is bifurcate in all three.

Male.—Parafrontals and parafacials gray with some golden pollen, both setulose; frontal rows divergent below in last three bristles; facilia setulose three-quarters distance from oral vibrissae to apex of second antennal segment; buccae with only golden hair; antennae and palpi black; outer verticals not distinct; three postocular rows.

Thorax gray-pollinose, longitudinally striped; anterior acrosticals indistinct; prescutellars well developed; four posterior dorsocentrals; three lateroscutellar pairs; one discoscutellar pair; one apioscutellar pair; propleuron setulose.

Abdomen gray; first two segments reddish laterally; with only lateral marginals; third reddish, with median marginals in addition to laterals; fourth reddish, with marginal row of twelve bristles; sternite of third segment with apical brush of setae.

Wings with small costal spine; first vein bare, third setulose; hind tibiae villous; genital segments dark; genitalia shown in Fig. 1, A–D; part of fifth sternite missing as shown in Fig. 1, C.

Holotype.—Male, Hollandia, Netherlands New Guinea, rain forest 250 feet, May 1945 (H. Hoogstraal). In collection of Chicago Natural History Museum.

Sarcophaga piva, n. sp.
Fig. 2

Most closely related to *Sarcophaga antilope* Böttcher, *S. alpha* Johnston and Teigs, and *S. hollandia* Roback. Differs from the first two in details of the genitalia and from the latter in possessing golden pollen on the body. The anterior lateral clasper is bifurcate in all three.

Male.—Parafrontals and parafacials golden-pollinose; both haired; frontal rows divergent below in last four bristles; facilia setulose a little over three-fifths distance from oral vibrissae to apex of second antennal segment; buccae with mostly black hair; some golden hair anterior to metacephalic suture; antennae and palpi black; outer verticals not distinguishable; three postocular rows.

Thorax golden-pollinose; three longitudinal brown stripes, two faint ones between these; six pair anterior acrosticals; prescutellars well developed; four or five posterior dorsocentrals; the fifth if present, weak; lateroscutellars, three pair; discoscutellars, one pair; apioscutellars, one pair; propleuron setulose.

Abdomen golden-pollinose; first two segments with lateral marginals only; third with median marginals in addition to the laterals; fourth with a complete marginal row.

Wings with weak costal spine; first vein bare third vein setulose; hind tibiae villous; genital segments black; genitalia shown in Fig. 2, A–E.

Female.—Outer verticals and proclinate frontoorbitals distinct; more golden hair on buccae than in male; posterior dorsocentrals six; four small anterior bristles and two large bristles before scutellum; scutellum without apicals; propleuron bare; genitalia brownish black.

Holotype.—Male, Piva River, Bougainville, Solomon Islands, June 25, 1944 (B. D. Valentine). In collection of Illinois Natural History Survey.

Allotype.—Female, same data as for holotype.

Sarcophaga lorena, n. sp.
Fig. 3

Closely related to *Sarcophaga setigera* Aldrich from which it differs in the shape of the distal segment of the aedeagus and the lack of median marginals on the second abdominal segment.

Male.—Parafrontals and parafacials gray; moderately setulose; frontal rows divergent below in last three bristles; facialia setulose three-fourths distance from oral vibrissae to apex of

[1] This paper is a joint contribution from the Department of Entomology, University of Illinois, and the Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey.

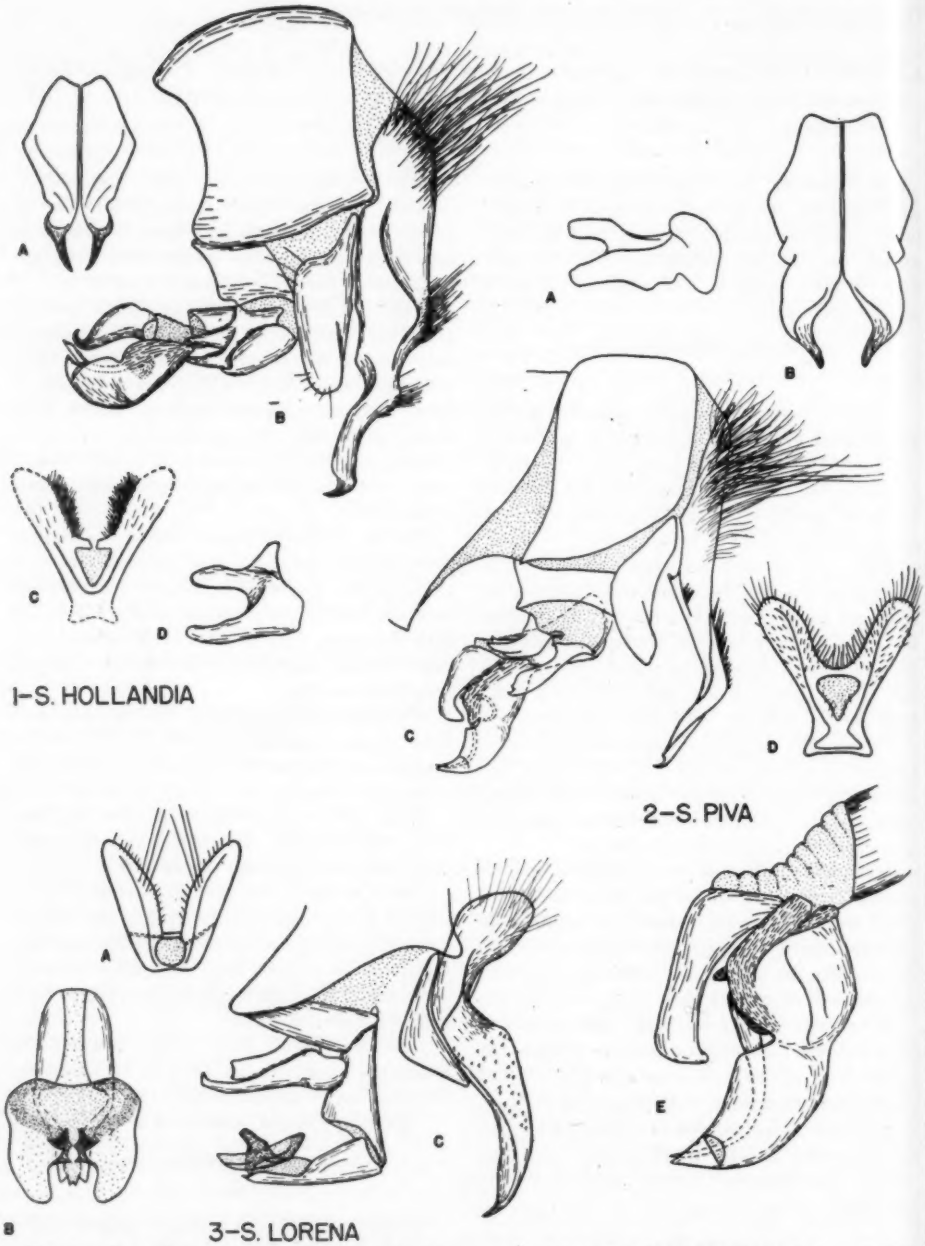
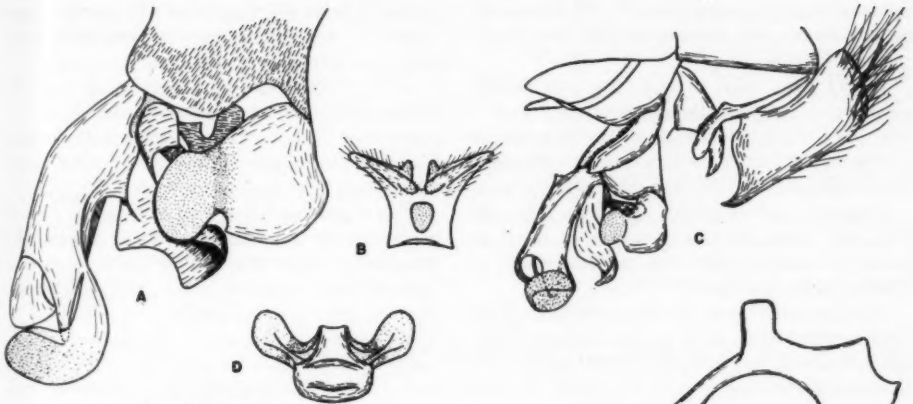
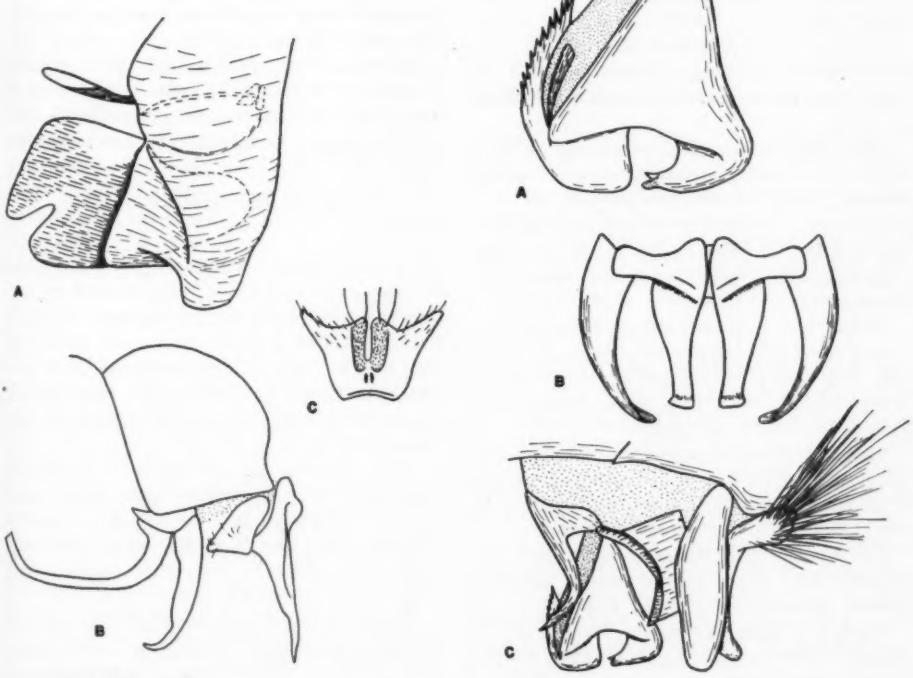


FIG. 1.—*Sarcophaga hollandia*, n. sp.: A, Anal forceps, caudal view; B, genitalia, lateral view; C, fifth sternite; D, left lateral clasper, ventral view. FIG. 2.—*Sarcophaga piva*, n. sp.: A, Left lateral clasper, ventral view; B, anal forceps, caudal view; C, genitalia, lateral view; D, fifth sternite; E, phallus, lateral view. FIG. 3.—*Sarcophaga lorena*, n. sp.: A, Fifth sternite; B, phallus, anterior view; C, genitalia, lateral view.



4–B. CARATA



5–R. TANCITURO

6–Z. CANTENEA

FIG. 4.—*Boettcheria carata*, n. sp.: A, Phallus, lateral view; B, fifth sternite; C, genitalia, lateral view; D, juxta, caudal view. FIG. 5.—*Ravinia tancituro*, n. sp.: A, Phallus, lateral view; B, accessory genital structures, lateral view; C, fifth sternite. FIG. 6.—*Zygastropyga cantenea*, n. sp.: A, Aedeagus, lateral view; B, anal forceps and anal plates, caudal view; C, genitalia, lateral view.

second antennal segment; buccae with black hair only; antennae and palpi brownish; outer verticals not distinct.

Thorax with usual three to five longitudinal stripes; gray-pollinose; three pair anterior acrosticals; prescutellars well developed; three posterior dorsocentrals; lateroscutellars, two or three pair; discoscutellars, one pair; apioscutellars, one pair.

Abdomen gray-pollinose; first two segments with only lateral marginals; third with marginal row of 12 bristles; fourth with marginal row of 16 bristles, reddish apically.

Costal spine present; first wing vein bare; third setulose; hind tibiae bare; genital segments light; genitalia shown in Fig. 3, A–C; fifth sternite cut as shown in Fig. 3, A.

Holotype.—Male, Riverhead, Long Island, N. Y., June 30, 1921. In the collection of Cornell University.

Boettcheria carata, n. sp.
Fig. 4

Closely allied to *Boettcheria litorosa* (Reinhard) and *B. praevolans* (Wulp). Differs from both in possessing outer verticals and lateral processes on the juxta.

Male.—Parafrontals and parafacials setulose; frontal rows sharply divergent below in last five bristles; facialia setulose one-half distance from oral vibrissae to apex of second antennal segment; buccae with only black hair; antennae and palpi brownish; outer verticals present; three postocular rows.

Thorax gray-pollinose, striped longitudinally; two or three pair anterior acrosticals; prescutellars very weak; three posterior dorsocentrals; lateroscutellars, three pair; discoscutellars, one pair; apioscutellars, one weak pair.

First two abdominal segments with only lateral marginals; third with a pair of median marginals in addition to laterals; fourth with a marginal row of 30 bristles; slightly red apically.

Costal spine weak; first vein bare; third vein setulose; hind tibiae villous; genital segments reddish; genitalia shown in Fig. 4, A–D.

Holotype.—Male, Monterey County, Calif., July 31, 1896. In collection of Chicago Natural History Museum.

Paratype.—Male, Custer, S. Dak. In collection of Illinois Natural History Survey.

Ravinia tancituro, n. sp.
Fig. 5

Most closely related to *Ravinia planifrons* (Aldrich) from which it differs in having three instead of four posterior dorsocentrals and in details of the phallus.

Male.—Parafrontals and parafacials slightly golden; lightly haired; frontal rows barely divergent below in last bristle; buccae with mostly black hair; antennae and palpi black; outer verticals absent; three postocular rows.

Thorax gray-pollinose with usual three to five longitudinal stripes; one pair anterior acrosticals; prescutellars very weak; three posterior dorsocentrals; lateroscutellars, two pair; discoscutellars, one pair; no apioscutellars.

Abdomen gray-pollinose; first and second segments with only lateral marginals; third with a pair of median marginals in addition to the laterals; fourth with a marginal row of about twelve bristles.

Costal spine lacking; first vein bare; third vein setulose; epaulet yellow; hind tibiae bare; first hypopygial segment dark, second yellowish; genitalia shown in Fig. 5, A–C.

Holotype.—Male, Mount Tancíturo, sweeping in meadow, 780 feet, Michoacán, Mexico. Fourth Hoogstraal Mexican Biological Expedition, 1941 (H. Hoogstraal). In collection of Chicago Natural History Museum.

Zygastropyga cantenea, n. sp.
Fig. 6

Close to *Zygastropyga aurea* Townsend and *Sarcophaga villipes* (Wulp). Differs from former in the greater divergence of the frontal row and from the latter in having the first vein bare. Details of phallus differ from both above species. Also near *Sabinata arizonica* Parker but differs in possessing strong outer verticals and a slight beard on the anterior tibiae.

Male.—Parafrontals and parafacials gray with slight brownish cast; both setulose; frontal rows divergent below in last four bristles; facialia setulose to the base of arista; buccae with only black hair; antennae and palpi brown; outer verticals well developed.

Thorax gray-pollinose; longitudinally striped; three pair anterior acrosticals; prescutellars large; four posterior dorsocentrals; lateroscutellars, three pair; discoscutellars, one pair; apioscutellars, one fine pair; propleuron bare.

Abdomen gray-pollinose; first two segments with lateral marginals only; third and fourth abdominal segments missing on holotype.

Costal spine lacking; first vein bare, third vein

setulose; hind tibiae villous; genital segments red; genitalia shown in Fig. 6, A–C.

Holotype.—Male, Huachuca Mountains, Cochise County, Ariz., July 21, 1930 (Leonora K. Gloyd). In collection of the University of Michigan.

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ENTOMOLOGY.—*A new genus of Bruchidae affecting* Hibiscus *in Argentina* (*Bruchinae: Acanthoscelidini*). J. C. BRIDWELL, Lignum, Va. (Communicated by Waldo L. Schmitt.)

On March 16, 1940, P. B. Denton, an oiler on a tanker then in the harbor of Buenos Aires, collected 10 adult bruchids on flowers along the River Plate which he subsequently brought to the late Herbert Spencer Barber in the United States National Museum, where they are now preserved. These 10 examples, no two of them alike in coloration, were so peculiar that soon after they reached me in January 1942 I wrote a description of the new genus *Bonaëreus*, here presented practically unchanged except for the identification of the species which has received seven specific or varietal names, all proposed by Maurice Pic.

The clue enabling me to name the bruchid and its host plant was found in Juan M. Bosq's highly esteemed "Segunda Lista de Coleópteros de la República Argentina Dañinos a la Agricultura," reprinted in 1943 from the "Ingeniería Agronómica Buenos Aires 1942" **4:** Nos. 18–22. In this reprint (p. 45) under no. 419 is the note:

> "*Bruchus inornatipennis* Pic
> Buenos Aires, Santa Fe, Corrientes. E[ntre] Rios.
> Ataca semillas de "rosa del Rio" (*Hibiscus cisplatinus* St. Hill.) en la misma planta. Es una especie variable."

Mr. Denton's flowers along the River Plate were thus identified as a plant much like our *Hibiscus militaris, moscheutos, coccineus,* and *lasiocarpus* in swamps and on river banks which support *Althaeus hibisci* (Olivier) (see Bridwell, 1946, *The genera of beetles of the family Bruchidae in America north of Mexico,* Journ. Washington Acad. Sci. **36:** 52–57).

The bibliography of Pic's plurinominate species had already been worked out thus:

Bruchus inlineatus Pic, 1930, Melanges **55:** 12: de l'Argentine. Also var. *testaceicollis* and var. *Deyrollei* on the same page.

Bruchus inornatipennis Pic, 1938, Rev. Soc. Ent. Argentina **10:** 20: Chaco argentin (Viana), with var. *obscurimembris:* Buenos Aires. On page 78 *inornatipennis* is referred to *inlineatus* as a variety, and on the same page *postreductus* and *latetestaceus* were described as varieties of *inlineatus.*[1]

Would that we could forget six of these names, for they represent the descriptions of individual specimens. After examining the Denton series in 1942, I wrote in my notes, "One of the 10 examples is practically entirely reddish testaceous, with apical joints of maxillary palpi, antennal club and claw joints of tarsi somewhat infuscate; another is almost entirely black with the basal five joints of antennae more or less reddish testaceous. The remaining specimens represent intermediates between these extremes,

[1] In 1946 Blackwelder (*Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America,* U. S. Nat. Mus. Bull. 185, pt. 4: 759) listed *inlineatus* and two varieties in *Acanthoscelides,* also separately listed *inornatipennis* and one variety in the same genus, overlooking Pic's merger of the species and the descriptions of two additional varieties on page 78.

some black with pale legs, others with the legs particolored and with the elytra partly red and partly black. In most of them the basal five joints of antennae and joint 11 are pale, while the club is dark above and pale beneath. They are all clothed throughout with thin fine pubescence but little obscuring the surface sculpture."

The combined generic and specific description of the genus **Bonaërius** and its genotype, *Bruchus inlineatus* Pic, follows:

Bonaërius inlineatus (Pic), 1930

Antennal joints 1–5 narrow, 6 small, twice as wide as 5; joints 7–10 transverse, cyathiform, forming with the expanded-ovate joint 11 a broad paddle-shaped club. Head short, frontal carina short, front about twice as broad as inner lobe of eye. Eye emarginate for one-half its length, convex, strongly projecting, temples narrow, abruptly declivous.

Pronotum flat and even above, resembling that of *Bruchus loti* Paykull in shape. Flanks separated from dorsum by a nearly straight marginal carina ending above the coxa remote from the front margin, the flanks not closed in front.

Intercoxal process of prosternum short, metasternum with a deep median longitudinal sulcus.

Scutellum quadrate, emarginately bidentate.

Elytra broader than pronotum, flattened above, subquadrate, without basal tubercles or elevations. Striae 2–6 and 10 reaching base; striae 5 and 6 abbreviate at apex. Striae strongly impressed and punctured, intervals flat.

Front and middle femora a little more than usually incrassate. Hind femur slender, about as wide as its coxa and narrower than the first sternite behind the coxa, a little flattened beneath, armed near apex within with a single blunt tooth, not reaching apex of abdomen.

Hind tibia slender, not longitudinally carinate beneath or on outer face; armed at apex beneath with two similar symmetrically disposed blunt teeth and above with three subdorsal apical teeth. Basitarsus gently arched, not apically produced beneath, without longitudinal carinae.

Pygidium convex, about as broad as long, oblique; apex of pygidium rounded and bent down, impressed on either side, a prominent little mound in the middle between the two poorly defined impressions.

While the general form resembles *Althaeus hibisci* (Olivier), 1795, *Abutiloneus idoneus* Bridwell, 1946, *Acanthoscelides aequalis* (Sharp), 1885, and other species of Acanthoscelidini known to affect seeds of Malvaceae, this resemblance is believed to result from their developing within rounded seeds rather than from any particular affinity among them. The peculiar pygidium distinguishes this genus from any other bruchid known to me.

HERPETOLOGY.—*Two Brazilian frogs:* Hyla werneri, *n. nom., and* Hyla similis, *n. sp.* Doris M. Cochran, United States National Museum.

In 1874, Meyer proposed the name *Hyperolius pygmaeus* for a frog from Jobi Island in Dutch New Guinea (Monatsb. Akad. Wiss. Berlin, 1874: 139). Loveridge (Bull. Mus. Comp. Zool. **101** (2): 397. 1948) lists this species as *Hyla pygmaea* (Meyer). It appears, therefore, that the name *Hyla pygmaea* proposed by Werner in 1894 for a frog from Santa Catharina, Brazil, should be renamed. I propose the following name for the Brazilian frog:

Hyla werneri, n. nom.

Hyla pygmaea (not of Meyer) Werner, Zool. Anz. **7**: 411. 1894 (type locality, Blumenau, Santa Catharina); Nieden, Das Tierreich, Anura 1: 289. 1923.

Hyla pigmaea Miranda-Ribeiro, Arch. Mus. Nac. Rio de Janeiro **27**: 83. 1923; Mello-Leitão, Zoo-geografia do Brasil: 341. 1937.

A gregarious little frog that quacks like a duck occurs in considerable numbers in the Federal District and within the city limits of Rio de Janeiro. So far no name already proposed seems to apply to this species. It is one of the *rubra* group, quite easily recognized as one of that group because of its very thick tibia and the yellow and brown reticulations on the posterior femur. But like all the group, this form also varies individually to a very considerable degree. It may intergrade with *hayii* in the lower mountain regions, and with *fuscovaria* in the uplands of southern Minas Gerais. Only further collecting and study can limit its precise range.

Hyla similis, n. sp.

Diagnosis.—Resembles *H. fuscovaria* A. Lutz in shape and structure of head and body and in a

tendency toward a grouping of dark elongate spots dorsolaterally. Differs in its significantly lower average length of head, femur, tibia, and foot, in the absence of clear-cut dorsolateral stripes, in the usually more finely spotted femur and tibia, and in its smaller size (maximum length 37 mm).

Description of the type.—An adult male, U.S.N.M. no. 97317, from Manguinhos near the city of Rio de Janeiro collected on February 25, 1935, by Joaquim Venancio. Vomerine teeth in two heavy, short, transverse groups almost continuous medially, between the posterior halves of the choanae; tongue about three-fifths as wide as mouth opening, roundly elliptical except for a deep notch on its free posterior margin; snout rather short, rounded when viewed from above and in profile, the upper jaw extending considerably beyond the lower; nostrils superolateral, greatly projecting, almost at the extreme tip of snout, separated from each other by an interval equal to two-thirds their distance from eye. Canthus rostralis rounded; loreal region slightly concave and very oblique. Eye large, very prominent, its diameter equal to its distance from nostril and to five-sixths the length of snout; interorbital diameter about 1¼ times the width of upper eyelid, greater than distance between nostrils. Tympanum very distinct, about two-thirds the width of eye, separated from eye by a very narrow interval equal to about one-eighth its own diameter. Fingers with a slight trace of a basal web, fourth very slightly longer than second but not reaching the base of third, which covers one-fourth the tympanic area; no rudiment of a pollex visible; toes one-half webbed, fifth slightly longer than third, disk of fourth toe covering about one-fourth the tympanic area; a distinct oval inner and a small, wartlike outer metatarsal tubercle; a faint glandular ridge along inside of tarsus and a still weaker outer tarsal ridge; no dermal appendage on heel. Body moderately heavy in build, in postaxillary region narrower than greatest width of head. When hind leg is adpressed, heel reaches to anterior border of eye; when limbs are laid along the body, knee and elbow are separated by a considerable interval; when hind legs are bent at right angles to the body, heels considerably overlap. Skin of upper parts with numerous elongate glandules and small tubercles, especially prominent on the center of the back; a narrow glandular ridge encircling upper part of tympanum and ending just behind it above the shoulder; skin of throat and chest with minute scattered pustules, that of belly coarsely granular on the breast, finely granular posteriorly and on the lower surface of femur; a slight skin fold across the chest and another much more prominent preceding it across the throat. A series of lateral folds on each side of the throat marking the presence of lateral gular sacs in the male.

Dimensions.—Head and body, 35 mm; head length, 11.5 mm; diameter of eye, 4 mm; width of head, 11 mm; femur, 15 mm; tibia, 16.5 mm; hind limb, 48 mm; forelimb, 19 mm; foot, 14 mm; hand, 9 mm.

Color in alcohol.—Dorsal ground color ecru-drab, with an indistinct light sepia triangle between the eyes; a dorsolateral longitudinal series of very irregular sepia spots sometimes anastomosing across the back, their outer margin dark and fairly straight, delineating a dorsolateral stripe of the pale ground color, this light stripe edged below with an indefinite dark stripe, which begins behind the tympanum and breaks up on the sides into a fine reticulation of dark on a light ground, continued and becoming coarser toward the groin; a faint dark line along canthus rostralis; loreal region and upper lip marbled slightly with drab; upper surface of femur with fine sepia reticulations fading out on the anterior surface, becoming darker and coarser on the posterior surface and enclosing irregular pale cinnamon areas; upper surface of tibia with three large diagonal spots; outer tarsus and upper arm indistinctly marbled with drab; ventral surface immaculate buff.

Color in life.—Some color notes on living specimens from Manguinhos were made on January 18, 1935. U.S.N.M. no. 97374: Malachite to sage green above, immaculate. Posterior femur chrome-yellow with brown reticulations. Throat citron-yellow; belly sulphur-yellow in the center, chrome-yellow toward the sides, immaculate. U.S.N.M. no. 97376: Dorsum clay color in center, with a drab dorsolateral stripe. Groin and ventral surface olive-buff, the sides with sepia spots. Fore and hind legs ochraceous, barred with raw umber. U.S.N.M. no. 97375: Dorsum light olive-gray, with coarse mouse-gray blotches edged with black. Upper and posterior parts of femur orange-ochraceous, mottled with dark sepia. Chin, chest, and lower parts of limbs ecru-drab; belly pale blue.

Variations.—Within the usual limits there is the same amount of confusing variation in this

species that is met with in the other members of the *rubra* group. The snout is usually rounded, but in about one-third of the examples it is slightly pointed. The tympanum, always distinct, may range from one-half to two-thirds the diameter of the eye in width. The interorbital diameter is often 1½ times the width of the upper eyelid, but in a few instances scarcely exceeds the eyelid in width. The distance from the posterior border of the tympanum to the tip of the snout varies between 31 and 36 percent of the total length of head and body, while the tibia is from 43 to 54 percent of this length. The adpressed heel may reach occasionally only to the posterior corner of the eye, most often to the center or anterior border of the eye, and rarely as far as the nostril. The disks of the fingers may be large, moderate or rather small, and as the tympanum itself varies considerably in size, the fourth finger disk may cover as little as one-fourth of its area to as much as two-thirds. The skin of the back is smooth in perhaps one-fourth of the specimens (this may depend on preservation to some extent), faintly granular all over in some, granular only on the posterior part in others.

The pattern seems as varied as do the physical dimensions. Usually there is a more or less distinct dark area between the eyes, but no other markings are at all constant. Some individuals are pale drab, with remnants of longitudinal dark stripes as in *rubra* appearing in this species as two rather irregular dark stripes enclosing a light area on each side of the back. In other specimens the upper one of the two dark stripes shortens and becomes crescentic; in many cases its inner edge approaches its fellow until they nearly fuse across the back, and in some cases they actually do become fused, with a few scattered light spots on them which may indicate their usual limits. Sometimes there is an irregular network of coarse dark spots down the back; sometimes an inverted V or its separated elements may appear on the sacral region. The upper part of the femur is usually irregularly spotted or reticulated; in only a few instances do these spots suggest the regular dark cross bars characterizing some other members of this group. Quite often the posterior surface of the femur reveals a rather large, very irregular, elongate light spot surrounded and set off by narrow dark reticulations. In other cases the posterior femur is finely marbled with small light and dark spots in about equal proportions. The upper surface of the tibia often has three irregular oval spots placed diagonally across it. Any of these dark spots may lighten, leaving only a narrow dark outline which suggests a parallelogram or an irregular circle. Numerous small dark dots scattered over the upper surfaces still further obscure the pattern. The sides sometimes show linear rows of dark dots more or less fused into a network, or often a scattering of fine dots with no particular arrangement. The groin quite often has a very pale (yellowish in life) area, confined sometimes to an elongate irregular spot encircled by darker, heavier reticulations. The ventral surface appears to be immaculate in the specimens at hand. A good many individuals show a dark brown stripe along the canthus, with considerable spotting on the upper lip; other specimens have a much lighter canthal stripe and the labial spots are reduced to a light marbling. Sometimes the canthal stripe is continued over the tympanum as a narrow dark line, widening behind the ear and often ending in front of the forearm, but also sometimes carried part way down the side as an irregular dark stripe.

Remarks.—It is perhaps rash to give a new name to another of the *rubra* group, the most variable of any in Brazil, but no formerly proposed name seems to be applicable to the form coming from within the Federal District. *H. x-signata* of Spix from Bahia is apparently nearest to *similis*, after *fuscovaria*, but fresh Bahian material is needed before an exact comparison can be made.

This species has the peculiar habit of "swarming," as hundreds appeared at one time on a tree outside the laboratory at the Instituto Oswaldo Cruz. The voice of the adult is a high-pitched *crack, crack, crack, crack*, sounding somewhat like that of a duck. Breeding takes place in March and April. The tadpoles metamorphose very rapidly, taking only 20 to 30 days to change into frogs, but they are rather delicate, as they die from the effects of too much sun if the water in which they live is not deep enough.

While this species is exceedingly plentiful at Manguinhos, it is not known from the southern part of the state of Rio de Janeiro. In fact, only two other examples at all resembling this form are known outside of the Manguinhos material. One of these is from Bom Successo, a few minutes' ride by automobile from Manguinhos, while the other, no. 96213, not in good condition but seeming to belong to the present species, is from Amorim near the city of Rio de Janeiro.

MATHEMATICAL ANALYSIS

	Head length	*Head width*	*Femur*	*Tibia*	*Foot*	*Hand*
N	49	49	49	49	49	49
M	33.7	31.9	42.0	48.0	39.0	26.2
σ	1.2	1.2	1.3	2.0	2.0	1.4
V	3.56	3.76	3.10	4.17	5.13	5.36
σ_m	0.01	0.54	0.44	0.59	0.73	0.77
Range	31.1–36.0	29.4–35.1	37.9–47.1	43.5–54.2	34.8–47.5	23.9–30.0

List of specimens.—Rio de Janeiro (state): U.S.N.M. no. 97317, the type of *Hyla similis*, and paratypes U.S.N.M. nos. 97312–6, 97318–52, 97374–6, from Manguinhos, all collected between January 18 and May 20, 1935, mostly by J. Venancio; U.S.N.M. nos. 96144–6 from Manguinhos collected in January 1922; U.S.N.M. no. 96203, an adult male from Bom Successo near the city of Rio de Janeiro, collected on October 25, 1928, and received from Dr. A. Lutz; U.S.N.M. no. 96213 from Amorim near the city of Rio de Janeiro collected in January 1926; U.S.N.M. nos. 81119–21 from Rio de Janeiro, collected in 1930 and received from Dr. A. Lutz.

HELMINTHOLOGY.—Hymenolepis johnsoni, *n. sp., a cestode from the vole* Microtus pennsylvanicus drummondii.

EVERETT L. SCHILLER, Arctic Health Research Center, Anchorage, Alaska. (Communicated by Harald A. Rehder.)

In connection with a separate work concerning morphological variation, the writer had occasion to study a number of hymenolepidid cestodes obtained from the autopsy of some preserved microtine rodents in the collection of the U. S. National Museum. Two of these cestodes, taken from a vole, *Microtus pennsylvanicus drummondii* (Audubon and Bachman), collected at Fort Rae, District of Mackenzie, Canada, represent a species of the genus *Hymenolepis* Weinland, 1858, which appears to be unknown in the parasitological literature and therefore is herein described as new.

The voles from which this material was taken were included among a large series of preserved rodents made available to Dr. Robert Rausch, of this laboratory, in conjunction with a survey of the helminth parasites of Nearctic microtine rodents. All hymenolepidid cestodes were turned over to the writer for study. This opportunity is taken to express to Dr. David H. Johnson, associate curator, division of mammals, U. S. National Museum, appreciation of his generous cooperation, which has made these studies possible.

Hymenolepis johnsoni, n. sp.

Figs. 1–3

Diagnosis.—Length of strobila 30–40 mm; maximum width 1.4 mm, attained at posterior end. Scolex diameter 150–180μ. Suckers, unarmed, 64 by 80μ. Evaginated rostellum 160μ long by 48μ wide at apex, which supports single row of 10 hooks 15μ in length. Strobila 108μ wide immediately posterior to base of scolex. Genital pores unilateral and dextral. Genital ducts pass dorsal to excretory canals. Cirrus sac muscular, averages 112μ in length by 43μ in diameter in mature proglottids. External seminal vesicle well developed, 115 by 72μ. Cirrus armed with minute spines. Testes, three in number, ovoid, 24 by 32μ, arranged in form of triangle with one testis poral and two aporal to ovary and vitelline gland. Deeply lobed ovary located in middle of proglottid. Vitelline gland lies ventral and posterior to ovary. Vagina ventral and posterior to cirrus sac. Saccate seminal receptacle prominent in mature proglottids, attains maximum size of 168 by 104μ. Uterus extends as slender irregular tube transversely across anterior part of proglottid, passing dorsal to excretory canals and reaching beyond them. Completely developed eggs not observed. Ventral longitudinal excretory canals measure 93μ in diameter; dorsal canals, 11μ in diameter.

Host.—*Microtus pennsylvanicus drummondii* (Audubon and Bachman).

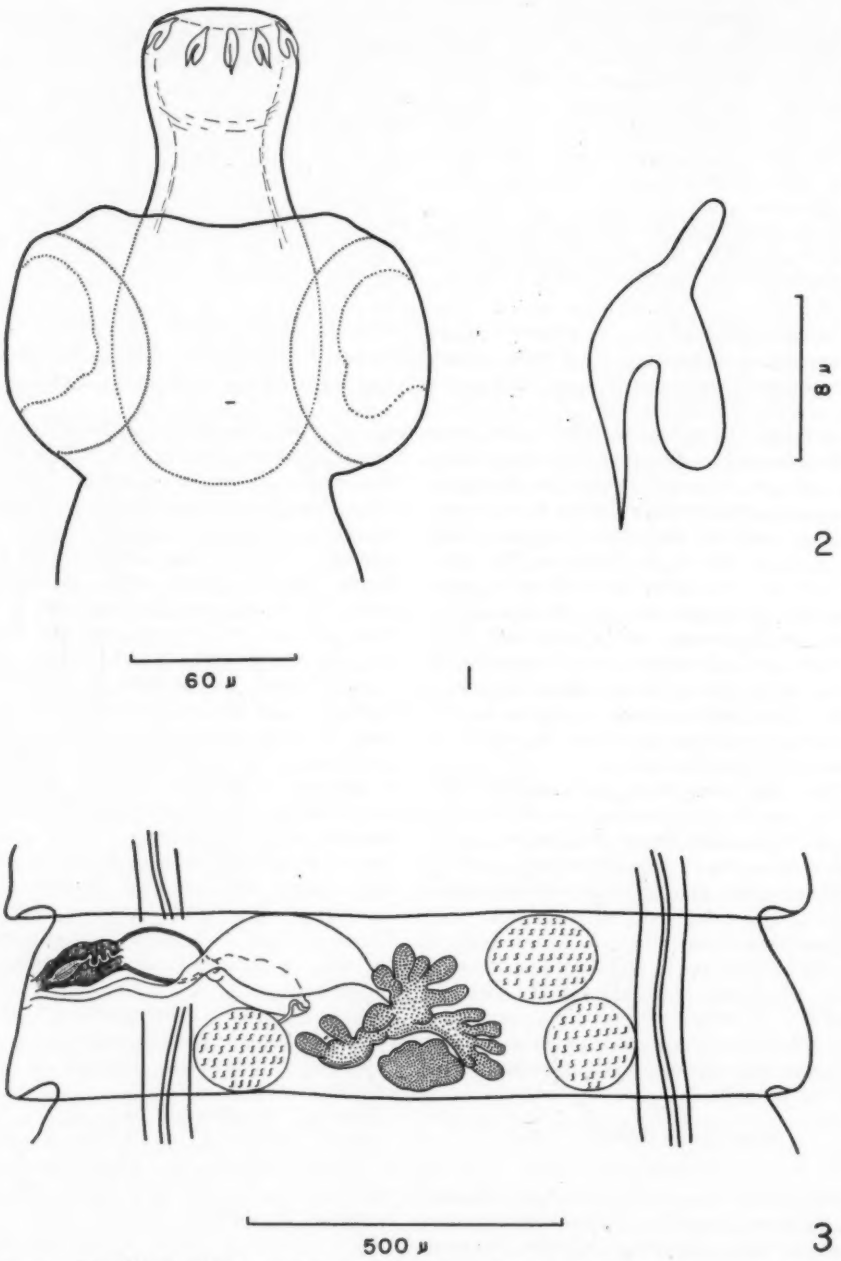
Locality.—Fort Rae, District of Mackenzie, Canada.

Habitat.—Small intestine.

Type.—One slide, no. 37340, containing an entire specimen, has been deposited in the Helminthological Collection of the U. S. National Museum.

DISCUSSION

Baer (1931) listed 14 armed species of *Hymenolepis* parasitic in rodents and added *H. muris-sylvatici* (Rudolphi, 1819) to this



FIGS. 1–3.—Morphological details of *Hymenolepis johnsoni*, n. sp.: 1, Scolex; 2, rostellar hook; 3, late mature proglottid (ventral view).

list. In a further review of the taxonomic status of this group (1932) he reduced the total number to 13. More recently Rider and Macy (1947) described *H. ondatrae* bringing the total again to 14. Of these, only four species have 10 rostellar hooks. These were found to differ from *H. johnsoni* as follows:

H. evaginata Barker and Andrews, 1915 (from *Ondatra zibethica* L.), has a strobila of much greater length (200–400 mm), a bilobed ovary, and smaller rostellar hooks (7μ) of a characteristically different shape.

H. pearsei Joyeux and Baer, 1930 (from *Hybomys univittatus* Peters), has a larger cirrus sac (520 by 60μ), testes arranged in a straight line, the ovary and vitelline gland poral to midline, and much longer rostellar hooks (60μ) of a different shape.

H. muris-sylvatici (Rudolphi, 1819) (from *Apodemus sylvaticus* (L.)) has an aspinose cirrus and larger rostellar hooks (23μ), which differ markedly in shape.

H. ondatrae Rider and Macy, 1947 (from *Ondatra zibethica occipitalis* (Elliot)), has a larger cirrus sac (30–35 by 150–220μ), an ovary that is smooth or may tend to be trilobate, and rostellar hooks that vary in number from 8 to 10, are of a much greater length (67–73μ), and have a distinctly different shape.

This cestode is named in honor of Dr. David H. Johnson, whose interest in these studies made possible the examination of valuable host material.

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ZOOLOGY.—*Geographical distribution of the species of nemerteans of the Arctic Ocean near Point Barrow, Alaska.*[1] WESLEY R. COE, Scripps Institution of Oceanography. (Communicated by Fenner A. Chace, Jr.)

Nemerteans occur along the borders of all the oceans, from beneath the Polar Seas northwest of Greenland (Coe, 1944) to the ice barrier surrounding the South Pole (Coe, 1950). Moreover most of the same genera, but not the same species, are found in both these extremes of latitude.

The floor of the Arctic Ocean near Point Barrow is evidently well adapted for populations of nemerteans, for Prof. and Mrs. George MacGinitie during their two years at the Arctic Research Laboratory[2] collected more than 300 specimens of these worms. Nemerteans were found at nearly all the dredging stations, from shallow water to depths of about 250 meters 12 to 16 miles from shore. The collections contained 24 recognizable species, among which are 7 species of *Amphiporus*, 4 of *Tubulanus*, 3 of *Micrura*, 4 of *Tetrastemma*, 2 of *Cerebratulus*, 1 each of *Lineus*, *Emplectonema*, *Nemertopsis*, and *Paranemertes*. As in other collections from Arctic seas, the genus *Amphiporus* has not only the greatest number of species but some of the species have also the largest populations. *A. angulatus* and *A. lactifloreus* are the most abundant species in the Point Barrow area. Ten of the species have not been reported previously from strictly Arctic seas, although three of these have been found in the nearby Bering Sea.

These collections are of particular interest because only three species of nemerteans were formerly known from that portion of the Arctic seas and the others contribute to an understanding of the circumpolar distribution of some of the species. Even at the present time no nemerteans are known from the Polar seas between the Point Barrow area and northwest Greenland on the east and Nova Zemblya and Franz Josef Land on the west.

From the Polar seas the populations of

[1] Contribution of the Scripps Institution of Oceanography, new series, no. 557.

[2] Supported by the Office of Naval Research through contracts with the California Institute of Technology and the Johns Hopkins University.

several of the species extend southward along the European, American, and Asiatic coasts. *Cerebratulus marginatus* may be mentioned as a species with an unusually extensive geographical distribution, for the range of this species extends from near King Karl Land, Spitsbergen, and elsewhere in the Arctic to Norway, Great Britain, the Mediterranean and Madeira in the eastern Atlantic and from Greenland to Labrador, Nova Scotia, New England, Cape Cod, and farther southward beneath the offshore current in the western Atlantic. It also extends from the Point Barrow area, Bering Sea, Pacific coast of Alaska and southward to southern California along the American coast, and to Kamchatka and Japan on the Asiatic coast. This does not imply that the populations in the present geological era are continuous through all this vast extent of territory, nor can it be assumed that the species originated in that portion of the globe which is now occupied by the Polar seas. The species presumably exists as isolated, localized, more or less widely separated populations. Moreover it is probable that it is even more widely distributed than is at present known.

Four other species, *Lineus ruber*, *Cerebratulus fuscus*, *Amphiporus lactifloreus*, and *Tetrastemma candidum*, similarly extend southward along the European and American Atlantic coasts, while *Amphiporus angulatus* extends from Greenland as far south as southern New England in the western Atlantic and from Point Barrow to California on the American coast, as well as to Japan on the Asiatic coast, but it has not been found in the eastern Atlantic.

Amphiporus lactifloreus occurs on both the European and American Atlantic coasts, as well as in the Arctic, but has not been reported from the Pacific, while *Tubulanus capistratus* is found on both sides of the Pacific, from Point Barrow to California and to Japan, but not in the Atlantic. The Point Barrow area therefore forms an intermediate link for those species formerly known to occur in the Polar seas north of Europe or near the coasts of Greenland, or both, and those on either the American or Asiatic Pacific coasts or both.

Relatively few species of nemerteans are known to occur in both the Northern and Southern Hemispheres. Of those here reported for the Point Barrow area, *Tubulanus annulatus*, *Lineus ruber*, *Cerebratulus fuscus*, and *Tetrastemma candidum* have been found also on the coast of South Africa and *Emplectonema gracile* on the coast of Chile.

The following list, arranged in systematic order, gives the geographical distribution of each of the species found in the Point Barrow area in so far as at present known. A similar list of the distribution of other species reported for Arctic seas has been published by Coe (1944).

Order Paleonemertea

Tubulanus albocinctus (Coe), 1904. This is the first record of this species in Arctic seas. It has been dredged previously among red algae at depths of 100 to 200 meters off the coast of southern California. One specimen, about 107 mm in length, was collected at a depth of 65 meters between 4 and 5 miles from shore off Point Barrow.

Tubulanus annulatus (Montagu), 1804. This species is widely distributed on the eastern shores of the North Atlantic, from Norway and Great Britain to the Mediterranean; it has also been reported from the South Atlantic, near the Cape of Good Hope. In the Arctic it has been dredged near King Karl Land, off Cape Platen, and in the Karajek Fiord, Greenland, as well as off the northwest coast of Greenland (Coe, 1944). In the Point Barrow area it was found at depths up to 126 meters and up to 7 miles from shore.

Tubulanus capistratus (Coe), 1901. This species is closely similar to the preceding but is without the white band on the dorsal surface of the head. It has been found in the intertidal zone and below along the Pacific coast of Alaska and southward to Monterey Bay, Calif., and it is also reported from Japan. In the Point Barrow area it was collected at depths of 3 and 131 meters, from near shore and 12 miles out.

Tubulanus frenatus (Coe), 1904. One specimen was found near Point Barrow. Previously recorded only from southern California.

Order Heteronemertea

Lineus ruber (O. F. Müller), 1771. Circumpolar; coasts of Siberia; Greenland; Norway and Great Britain to the Mediterranean, Madeira and South Africa; Labrador to southern New England;

Alaska to California. In the collections from the Point Barrow area only two specimens were assigned to this species. One of these was found near shore and the other ot a depth of 136 meters 8 miles out.

Micrura alaskensis Coe, 1901. A common species in the intertidal zone and below along the Pacific coast of Alaska and southward to northern Mexico. Found also in Japan. In the Point Barrow area only four individuals were obtained. One of these was found near shore and the others 4 to 7 miles out, at depths of 50 to 65 meters.

Micrura impressa (Stimpson), 1857. Originally described from an individual dredged in Bering Strait. Later reported from Japan (Yamaoka, 1940). One specimen measuring 97 mm in length and 9 mm in width when contracted was found washed ashore at Point Barrow.

Micrura purpurea (Dalyell), 1853. Reported in Arctic seas northwest of Greenland, Karajak Fiord and Hinlopen Strait at depths of 45 to 115 meters (Coe, 1944). Common on European coasts from the intertidal zone to depths of 200 meters or more. One specimen was obtained in the Point Barrow area at a depth of 143 meters, 16 miles from shore.

(*Cerebratulus barentsi* Bürger, 1895. The minor morphological features which have been thought to separate this species from *C. marginatus* have evidently resulted from different states of contraction of the head. Hence *C. barentsi* is no longer considered to be a valid species.)

Cerebratulus fuscus (McIntosh), 1873–4. This is a species with a very wide geographical distribution, for it has been reported not only from the coasts of Greenland and elsewhere in Arctic seas, but also from Norway and Great Britain to the Mediterranean, as well as South Africa and Florida (Coe, 1951). The single specimen collected in the Point Barrow area was dredged at a depth of 41 meters, 3.5 miles from shore.

Cerebratulus marginatus Renier, 1804. This species has the wide circumpolar distribution previously mentioned, being found on European coasts as far south as Madeira; on the eastern North American coasts it extends southward to Cape Cod and farther south beneath the offshore current; on the western North American coast southward to southern California and in the western Pacific as far south as Japan. In the Arctic it has been reported from King Karl Land, Bremer Sound, Hinlopen Strait, East Spisbergen, and northwest Greenland. In the Point Barrow area it was found at depths of 61 to 222 meters, 5 to 12 miles from shore.

Order HOPLONEMERTEA

Emplectonema gracile (Johnston), 1837. One small specimen about 30 mm long and 1 to 2 mm in diameter after preservation was obtained in the Point Barrow area at a depth of 38 meters. This is one of the most widely distributed of all species of nemerteans, being abundant in the intertidal zone and below, on the northern coasts of Europe and southward to Madeira; on the coasts of Alaska to California and northern Mexico, and it has been reported also from Chile, as well as from Kamchatka and Japan. It has not been recorded previously from Arctic areas.

Paranemertes peregrina Coe, 1901. In many localities this is the most abundant nemertean in the intertidal zone along the Pacific coast of Alaska and southward to California. It has also been reported from the Aleutian Islands, Kamchatka and Japan. Only a single representative of this species was found in the Point Barrow area.

Nemertopsis gracilis Coe, 1904. Previously reported from Pugent Sound to northern Mexico. Only one specimen was dredged in the Point Barrow area.

Amphiporus angulatus (Fabricius), 1774. The collections indicate that this is the most abundant nemertean in the Point Barrow region. Because of the relatively large size of many individuals and their conspicuous coloration, it is unlikely that they would be overlooked by the collector. This species was found at 9 stations, where the depths were between 12 and 226 meters. The distance from shore varied from 2.75 to 16 miles. This species is widely distributed in Arctic seas, having been reported from near Greenland, Baffin Bay, Davis Strait, Labrador, Nova Scotia, southward to Cape Cod and further south beneath the offshore Arctic current. On the Pacific coast of North America it extends through Bering Sea, along the coast of Alaska and south as far as Point Conception, California. On the Asiatic coast it has been found on the shores of Kamchatka and Japan. It was collected by Stimpson (1857) in Bering Strait.

Amphiporus formidabilis Griffin, 1898. Previously recorded from Bering Island, Aleutian Islands, coast of Alaska and southward to Monterey Bay, California. Two specimens in the Point Barrow collections were dredged at depths of about 62 and 226 meters, 5 to 12 miles from shore.

Amphiporus groenlandicus (Oersted), 1844. This is another species that is widely distributed in Arctic seas, having been reported from both the eastern and western coasts of Greenland, from Hinlopen Strait, Barents Sea, and from the waters off King Karl Land, Jena Island, Franz Josef Land, and Spitzbergen at depths of 4 to 450 meters. The same or a closely similar species, *A. caecus* Verrill, also without ocelli, has been dredged at a depth of about 35 meters off the New England coast (Coe, 1943). *A. groenlandicus* was found in the Point Barrow area at depths of 40 to 247 meters and up to 12 miles from shore.

Amphiporus imparispinosus Griffin, 1898. This has been reported previously from the Bering Sea and it is abundant in many localities in the intertidal zone and below, along the coast of Alaska and southward to Ensenada, Mexico. The typical form, which has three pouches of accessory stylets is often associated with the variety *similis*, which has only two. The species was found in the Point Barrow area at depths of 37 to 104 meters and up to 7 miles from shore.

Amphiporus lactifloreus (Johnston) 1828. With the exception of *Amphiporus angulatus*, this species appears to be the most abundant nemertean in the Point Barrow area. The species was found at 13 stations, where the depths varied from 12 to 226 meters and at distances up to 12 miles from shore. It is widely distributed along the shores of the Arctic and North Atlantic oceans, extending southward to the Mediterranean Sea and on the American coast as far as Cape Cod. Except in the far north it occurs in the intertidal zone and in some areas to depths of 200 meters.

Amphiporus macracanthus Coe, 1905. This species is known only from the Arctic coast of Alaska, where it was collected as early as 1882 near Cape Smyth and at a later date at Wainwright Inlet (Coe, 1905). In the Point Barrow area it was found at depths of 38 to 53 meters and up to 4 miles from shore.

Amphiporus pacificus Coe, 1905. Previously dredged at depths of 70 to 180 meters in the Bering Sea and off the coasts of Washington and California. Collected in the Point Barrow area at depths of 9 to 226 meters and up to 12 miles from shore.

Tetrastemma aberrans Coe, 1901. Several specimens were dredged at depths of less than 40 meters. Previously known only from the coast of Alaska.

Tetrastemma bicolor Coe, 1901. Previously known only from Kodiak Island, Alaska. One individual was dredged at a depth of 50 meters about 3 miles from Point Barrow.

Tetrastemma candidum (Müller), 1774. Circumpolar; Greenland; Norway to Madeira; South Africa; Labrador to southern New England and southward to northern Florida; northern coast of the Gulf of Mexico; Alaska to California and northern Mexico. In the Point Barrow area the species was found at depths of 34 to 145 meters and up to 16 miles from shore.

Tetrastemma coronatum (Quatrefages), 1846. The collection from the Point Barrow area was accompanied by a colored photograph of an individual of this species that had been dredged at a depth of 50 meters, about 3 miles from shore. Common on European coasts and the Mediterranean. Reported also in Japan (Yamaoka, 1940).

All the specimens in this collection are in the U. S. National Museum.

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NEW MEMBERS OF THE ACADEMY

There follows a list of persons elected to membership in the Academy, by vote of its Board of Managers, since March 1, 1950, who have since qualified as members in accordance with the bylaws. The bases for election are stated with the names of the new members.

RESIDENT

Elected March 20, 1950

GEORGE S. SWITZER, associate curator of mineralogy and petrology, U. S. National Museum, in recognition of his studies of systematic mineralogy.

Elected April 17, 1950

HERBERT LEADERMAN, physicist, rubber section, National Bureau of Standards, in recognition of his work on the physics of high polymers and in particular his contributions to rheology as exemplified by research on the creep and flow of rubbers and fibers.

Elected May 15, 1950

J. M. AMBERSON, commander, Medical Corps Reserve, USNR, chief of tropical medicine, Naval Medical School, in recognition of his studies of tropical diseases, especially cholera and schistosomiasis, and for his leadership in field surveys to probe into the epidemiology of these diseases and improved methods for their control.

ROBERT G. BRECKENRIDGE, physicist, National Bureau of Standards, in recognition of his contributions to chemical physics and in particular his work on the electrical properties of solids.

LLOYD A. BURKEY, bacteriologist, Bureau of Dairy Industry, in recognition of his studies on the pectin-fermenting bacteria, his contributions on the bacteriology of Swiss cheese and on cultured milks, and his contributions in bacteriological studies on the detection, diagnosis, and causes of bovine mastitis.

WILLIAM D. FIELD, associate curator of insects, U. S. National Museum, in recognition of his taxonomic and distributional studies of the Lepidoptera, the butterflies and larger moths in particular.

ROBERT TRAUB, major, U. S. Army, chief, department of parasitology, Army Medical Center, in recognition of outstanding contributions to the systematics of fleas and to the epidemiology of scrub typhus.

Elected October 30, 1950

B. M. AXILROD, physicist, National Bureau of Standards, in recognition of his contributions to knowledge of the mechanical properties of plastics and of cohesive forces in crystals of the rare gases.

E. W. CANNON, assistant chief, applied mathematics division, National Bureau of Standards, in recognition of his contributions to the development of high-speed automatic computing machinery, and to the establishment of a strong federal program in applied mathematics.

HAROLD E. CLEAVES, chief, chemical metallurgy section, National Bureau of Standards, in recognition of his contributions in the field of physical metallurgy, particularly in the preparation and determination of the properties of the purest iron ever prepared.

IRVING A. DENISON, chief, underground corrosion section, National Bureau of Standards, in recognition of his contributions to theory of corrosion and corrosion prevention in soils and measurement of the corrosion of metals in soils.

THOMAS G. DIGGES, chief, thermal metallurgy section, National Bureau of Standards, in recognition of his contributions to metallurgy, in particular his studies of machinability, hardenability, and creep.

GEORGE A. ELLINGER, chief, optical metallurgy section, National Bureau of Standards, in recognition of his work in the field of metallurgy, particularly in metallography and corrosion.

EARL K. FISCHER, chief, organic coatings section, National Bureau of Standards, in recognition of his contributions to rheology and colloid chemistry.

ALPHONSE F. FORZIATI, research associate of the American Dental Association at the National Bureau of Standards, in recognition of his contributions to physical chemistry, in particular his studies of the purification and properties of petroleum hydrocarbons.

THOMAS WALLER GEORGE, head, armor materials section, Naval Research Laboratory, in recognition of his studies of the mechanical strength of solids, in particular the relation between strain rate and strength.

WAYNE C. HALL, superintendent, electricity division, Naval Research Laboratory, in recognition of his work on electrostatic charging of aircraft and on thermal conductivity.

HOMER D. HOLLER, general physical scientist, National Bureau of Standards, in recognition of his contributions to the theory of corrosion and his applications of electrical theory to corrosion and corrosion prevention.

DONALD HUBBARD, chemist, glass section, National Bureau of Standards, in recognition of his contributions to physical chemistry and in particular his studies of photographic emulsions and the relation between chemical durability and pH response of glass electrodes.

PETER KING, branch head, chemistry division, Naval Research Laboratory, in recognition of his contributions to chemistry and optics, in particular his studies of low-reflecting coatings.

LUTHER B. LOCKHART, JR., research chemist, Naval Research Laboratory, in recognition of his work on separation of the constituents of petroleum and pilot plant work on extraction of alumina from clay.

HOWARD F. MCMURDIE, chief, constitution and microstructure section, National Bureau of Standards, in recognition of his work in applied crystallography and phase studies in inorganic chemistry, especially as regards portland cement, ceramics, and dry cells.

W. T. READ, chemical adviser, general staff, G-4, U. S. Army, in recognition of his contributions to organic chemistry, particularly the chemistry of hydrazines and hydantoins, to education in chemical engineering, and to the history of chemistry.

JOHN A. SANDERSON, superintendent, optics division, Naval Research Laboratory, in recognition of his contributions to optics, particularly his researches in the infrared.

A. L. SHALOWITZ, chief, research, review, and technical information section, U. S. Coast and Geodetic Survey, and special assistant to the director, in recognition of his research work in the field of nautical cartography and in the standardization of practices relating to hydrographic surveying, particularly in the matter of interpretation of charts and surveys for scientific and legal purposes.

JAMES L. THOMAS, chief, resistance measurements section, National Bureau of Standards, in recognition of his contributions to physics and in particular to precise electrical measurements.

LEROY W. TILTON, physicist, optical instruments section, National Bureau of Standards, in recognition of his contributions to physics, particularly in the field of refractometry.

HERBERT C. VACHER, X-ray metallographist, National Bureau of Standards, in recognition of his researches on gases in metals, physical chemistry of steel making, and plastic deformation of metals.

SAMUEL G. WEISSBERG, physicist, organic plastics section, National Bureau of Standards, in recognition of his work on the properties of high polymers in solution and his contributions to our knowledge of the properties of building materials and aircraft finishes.

Elected November 20, 1950

B. D. BURKS, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of his contributions to the classification and biology of insects, especially his studies in the taxonomy of parasitic wasps and of mayflies.

FRANK R. CALDWELL, physicist, combustion section, National Bureau of Standards, in recognition of his contributions in the field of combustion, particularly as applied in gas turbines and jet engines.

ANDREW I. DAHL, physicist in charge of gas temperature measurements, National Bureau of Standards, in recognition of the development of thermocouple pyrometers for use in gas turbines and jet engines.

MILDRED A. DOSS, zoologist, zoological division, Bureau of Animal Industry, in recognition of her servies to the science of parasitology through the maintenance of the Index Catalogue of Medical and Veterinary Zoology, which provides a working tool of inestimable value to parasitologists the world over.

U. FANO, physicist, National Bureau of Standards, in recognition of his contributions to theoretical nuclear physics, in particular his studies on the penetration of radiation through barriers.

MARION M. FARR, parasitologist, zoological division, Bureau of Animal Industry, in recognition of her work on the Protozoa and protozoan diseases on poultry.

MARSHALL C. GARDNER, biologist, U. S. Fish and Wildlife Service, in recognition of his research in mammalogy, and in particular his researches on the taxonomy of the mammalian genera *Sigmodon* and *Lynx*.

DEFOE C. GINNINGS, chemist in charge of high-temperature calorimetry, National Bureau of Standards, in recognition of his contributions to calorimetry, and in particular of the development of the ice calorimeter and its application to accurate measurements of heat capacities at high temperatures.

FRANK L. HOWARD, acting chief, engine fuels section, National Bureau of Standards, in recognition of his contributions to the synthesis of hydrocarbons of high purity, particularly those of interest in internal combustion engines.

K. C. KATES, parasitologist, zoological division, Bureau of Animal Industry, in recognition of his contributions to the knowledge of parasites and parasitic diseases of swine and sheep.

H. WILLIAM KOCH, chief, betatron section, National Bureau of Standards, in recognition of his contributions to nuclear physics, in particular to betatron applications, and his studies of the interactions of high energy gamma rays with matter.

S. A. MCKEE, chief, engines and lubrication section, National Bureau of Standards, in recognition of his contributions in the field of lubrication and wear.

RUSSELL B. SCOTT, chief, cryogenic section, National Bureau of Standards, in recognition of his contributions to cryogenic research, particularly his calorimetric investigations at low temperatures.

DOYS A. SHORB, parasitologist, Bureau of Animal Industry, in recognition of his extensive investigations of parasites and parasitic diseases of livestock.

MARY S. SHORB, research professor, department of poultry husbandry, University of Maryland, in recognition of her contributions to the science of nutrition, especially the development of methods of assay for vitamin B-12 and related investigations.

BANCROFT W. SITTERLY, professor of mathematics and associate dean, American University, in recognition of his contributions to astronomy, and in particular investigations on eclipsing binary stars, stellar magnitudes, and stellar parallaxes; also studies in the theory of hyperbolic systems of radio navigation, in particular the Loran system.

CHARLOTTE M. SITTERLY, physicist, spectroscopy section, National Bureau of Standards, in recognition of her contributions to astrophysics, in particular researches on the solar and sun spot spectra, and contributions to the study of atomic spectra and tables of atomic energy levels.

JOHN TODD, chief, computation laboratory, National Bureau of Standards, in recognition of his contribution to numerical analysis in particular, and to mathematics in general.

GEORGE B. VOGT, entomologist, Bureau of Entomology and Plant Quarantine, in recognition of his original and unusually searching work in insect biology and taxonomy, especially that dealing with Texan woodboring beetles.

KATHARINE WAY, physicist, National Bureau of Standards, in recognition of her contributions to nuclear physics, in particular her work on binding energies and fission products.

HAROLD O. WYCKOFF, chief, X-ray section, National Bureau of Standards, in recognition of his contributions to radiation physics and in particular his researches on the protection requirements for electromagnetic radiations.

Elected January 16, 1951

FRANCIS A. ARNOLD, JR., associate director, National Institute of Dental Research, National Institutes of Health, in recognition of his contributions to dental research, and in particular his contributions to the epidemiology of dental caries with particular reference to the role of naturally occurring fluorine in water supplies.

ALFRED E. BROWN, assistant director, Harris Research Laboratories, in recognition of his work on the chemical modification of proteins, and in particular his researches on modification of wool and other fibrous proteins.

LYMAN FOURT, research associate, Harris Research Laboratories, in recognition of his work in the testing of textiles and in their evaluation for clothing.

A. R. GLASGOW, Jr., chemist, National Bureau of Standards, in recognition of his studies in the separation, purification, and analysis of petroleum hydrocarbons.

EDWARD G. HAMPP, research associate, National Institutes of Health, in recognition of his fundamental contributions to knowledge of diseases of the oral cavity, and in particular his studies on oral spirochetes and the isolation of *Borrelia vincentii* in pure culture.

HARRY JOSEPH KEEGAN, physicist, National Bureau of Standards, in recognition of his contributions to optics, in particular his work in spectrophotometry and its application to the specification of color.

L. ROLAND KUHN, lieutenant colonel, chief, department of bacteriology, Army Medical Department Research and Graduate School, in recognition of his contributions to microbiology in particular his outstanding studies on *Cryptococcus hominis*.

LOUISE H. MARSHALL, physiologist, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, in recognition of her contributions to high-altitude physiology, particularly in respiration and renal hemodynamics.

WADE H. MARSHALL, research fellow, National Institutes of Health, in recognition of his con-

tributions to physiology, in particular his studies of the central nervous system, sensory areas, and pathways of the brain.

F. J. McCLURE, biochemist, National Institutes of Health, in recognition of his studies of the physiological effects of fluorine, particularly of the relation of fluoride to dental caries.

ANTHONY M. SCHWARTZ, manager, industrial chemicals division, Harris Research Laboratories, in recognition of his work on the preparation and utilization of surface-active agents, and the theory of their action.

WILLIE W. SMITH, physiologist, National Institutes of Health, in recognition of her contributions in physiology, particularly concerning renal function and radiation biology.

JOEL WARREN, chief, division of virus research and biophysics, Army Medical Service Graduate School, in recognition of his contributions to virus diseases, and in particular his researches on epidemic encephalitis and encephalomyocarditis.

Elected February 12, 1951

H. HERBERT HOWE, mathematician, U. S. Coast and Geodetic Survey, in recognition of his outstanding contributions to the theory of geomagnetism and numerous publications of magnetic data.

DAVID G. KNAPP, mathematician, U. S. Coast and Geodetic Survey, in recognition of his charting of geomagnetic data and the library classification of research data, especially in geomagnetism, magnetism, geoelectricity, and seismology.

M. LINDEMAN PHILLIPS, physicist, National Bureau of Standards, in recognition of her investigations in terrestrial magnetism and atmospheric electricity, and her studies of incandescent solids.

RALPH STAIR, physicist, National Bureau of Standards, in recognition of his work in radiometry, in particular the measurment of atmospheric ozone and the intensity and ultraviolet spectral distribution of the radiant energy from the sun.

Elected April 16, 1951

THOMAS J. HICKLEY, electrical engineer, U. S. Coast and Geodetic Survey, in recognition of his contribution to cartography through research and development of electronic hydrographic surveying equipment, particularly the electronic position indicator.

ROBERT W. LEUKEL, plant pathologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his outstanding contributions to plant pathology, especially with respect to seed treatments of cereals and the identification of the organism causing the Milo disease.

Elected May 14, 1951

HAIG DERMAN, cytologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his outstanding researches on the cytology of plant hybrids and chimeras.

MONROE E. FREEMAN, chief, department of biochemistry, Army Medical Center, in recognition of his services as a teacher of chemistry and his research contributions in biochemistry.

RICHARD TOUSEY, head, micron waves branch, optics division, Naval Research Laboratory, in recognition of his work on solar spectroscopy from rockets, and spectroscopy in the vacuum ultraviolet region.

Elected June 18, 1951

LOUIS E. BARBROW, electrical engineer, National Bureau of Standards, in recognition of his contributions to photometry and lighting, and in particular to the development of federal and ASA standards and specifications for lamp and electrical supplies, for his establishment of new luminous flux values for mercury lamps, and for his effective furtherance, as secretary of the U. S. National Committee of the International Commission on Illumination, of international standards and practice in the field of lighting.

HOWARD S. BEAN, chief, capacity, density, and fluid meters section, National Bureau of Standards, in recognition of his work in metrology, especially his researches in the measurement of fluids, especially gases, with orifice meters.

ROGER W. CURTIS, physicist, ordnance development division, National Bureau of Standards, in recognition of his contributions and work in absolute measurement of electrical current, ultrasonic absorption in gases, electronics.

FLORENCE HOOPER FORZIATI, chemist, National Bureau of Standards, in recognition of her contributions to carbohydrate chemistry, and in particular her researches on the chemistry of cellulose.

WEBB E. HAYMAKER, chief, neuropathology, Armed Forces Institute of Pathology, in recognition of his contributions to experimental neuropathology.

JOSEPH VINCENT KARABINOS, chemist, National Bureau of Standards, in recognition of his contributions to organic chemistry, particularly on heparin, on reductive desulfurization, aromatic hydrocarbons, and the isolation of substances from natural sources.

BENJAMIN L. PAGE, physicist, National Bureau of Standards, in recognition of his work in metrology, especially in length and angle measurements.

JOHN THOMAS PRESLEY, plant pathologist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his work on the diseases of cotton, in particular his researches on the root rot of cotton and the breeding of disease-resistant varieties.

ROBERT FRANCIS REITEMEIER, soil scientist, Bureau of Plant Industry, Soils, and Agricultural Engineering, in recognition of his contributions to soil science, in particular his researches on metaphosphates, soil colloids, semimicroanalysis, and soil fertility.

MAURICE M. SHAPIRO, head, heavy particle physics branch, nucleonics division, Naval Research Laboratory, in recognition of his work in cosmic rays and in nuclear and pile physics.

KARL SOLLNER, chief biochemist, National Institutes of Health, in recognition of his extensive research into theory and experimental practice in the fields of physical chemistry of colloids as related to membranes, permeability, ultrasonics and osmosis; thixotropy; sols and gels; emulsions; and physical biochemistry.

RAY PALMER TEELE, Jr., physicist, National Bureau of Standards, in recognition of his contributions to photometry and lighting, and in particular the development of the physical photometer, the photometry of phosphorescent materials, and his contributions to international agreement on photometric standards.

HORACE MAYNARD TRENT, head, applied mathematics branch, Naval Research Laboratory, in recognition of his work in electromechanical analogies and in mathematical theories of mechanics.

NONRESIDENT

Elected May 15, 1950

HARRY D. PRATT, scientist, U. S. Public Health Service, Atlanta, Ga., in recognition of his taxonomic studies of insects of economic importance, especially the parasitic Hymenoptera and the disease-carrying Diptera.

Elected November 20, 1950

WILLARD H. BENNETT, physics department, University of Arkansas, in recognition of his studies of negative ions in electrical discharges and gases.

COLIN CAMPBELL SANBORN, curator of mammals, Chicago Natural History Museum, in recognition of his contributions to systematic mammalogy, particularly the classification of the Chiroptera and faunal studies in South America.

CLAUDE E. SCHAEFFER, curator, Museum of the Plains Indian, Browning, Mont., in recognition of his contributions to the ethnography of the American Northwest and to the organization of scientific archeology in Pennsylvania.

Elected December 18, 1950

HAROLD J. HOGE, physical division, research department, Leeds Northrup Co., Philadelphia, Pa., in recognition of his contributions to thermometry, particularly in the range below the boiling point of oxygen.

Elected January 16, 1951

E. RAYMOND HALL, director, Museum of Natural History, University of Kansas, Lawrence, Kans., in recognition of his contributions to the systematic study of recent and fossil mammals, especially with regard to the fauna of western North America and to the mustelid carnivores.

ROBERT RAUSCH, parasitologist in charge, animal-borne disease section, Arctic Health Research Center, U. S. Public Health Service, Anchorage, Alaska, in recognition of his studies of host-parasite ecology, in particular the helminth parasites in wildlife and the relation of these diseases to public health.

S. F. SNIESZKO, director, microbiological laboratory, U. S. Fish and Wildlife Service, Kearneysville, W. Va., in recognition of his contributions to plant and fish diseases and in particular his studies of bacteria which cause fish diseases.

Elected April 16, 1951

EARL S. BELOTE, mathematician, U. S. Coast and Geodetic Survey, New York City, in recognition of his contribution to geodesy through research and development in the methods of adjusting the observational data from triangulation and traverse measurements.

Elected May 14, 1951

BIRDSALL N. CARLE, pathologist, U. S. Marine Hospital, New Orleans, La., in recognition of his

research in infectious diseases, particularly in the field of brucellosis.

GEORGE A. LLANO, research specialist, Headquarters Air University, U. S. Air Force, in recognition of his contributions to the taxonomy and ecology of lichens and in particular his recent studies of the relation of these plants to arctic conditions.

Obituaries

OWEN BERT FRENCH, geodesist, died at his home, Lakewood, Ohio, on February 1, 1951, ending a long, useful, and colorful career. He was born near Cleveland, Ohio, on December 17, 1865, the son of Marshall and Melissa A. French. He received a B.S. degree in 1888 and a C.E. degree in 1905, both at the Case School of Applied Science. On May 27, 1907, he married Marie Wilhelmine Schott, of Washington, D. C.

In 1889 Mr. French joined the U. S. Coast and Geodetic Survey, which he served until 1915. His work carried him throughout the United States as well as Alaska and Hawaii. His duties were many and varied and included topographic, hydrographic, magnetic, and astronomic surveys; on the last he became an authority. In 1894 he was in charge of scientific work on Walter Wellman's first polar trip. Early in the century he was engaged on astronomic work along the boundary between Alaska and British Columbia, in 1906 on triangulation and base measurements, as well as astronomic surveys along the United States-Canadian Boundary. He made the first investigation of invar (nickel steel) tapes for use in the measurement of base lines, proving them to be far superior to steel tapes for this purpose.

Mr. French retired from the Coast and Geodetic Survey in 1915 and practiced as a consulting geodesist in 1916–17. In 1918–19 he was a professor of geodesy and astronomy at the Institute of Military Surveying, Peking, China, where he was awarded the Wheat decoration. From 1920 to 1933 he was professor of surveying and astronomy at George Washington University, after which he continued his practice as a consulting geodesist.

Thorough and painstaking in all his work, Mr. French became well known at home and abroad as one of the leading practical geodesists of his time. He was author of many reports and papers, among which are *Invar tapes on the measurement of six primary base lines* and *Report on the Scheimpflug method of aerial photography*, and co-author of *Determination of the difference in longitude between each two of the stations Washington, Cambridge, and Far Rockaway*. He also wrote a large portion of Gillespie's *Higher surveying*.

Mr. French had been a member of the American Society for the Advancement of Science, American Society of Civil Engineers, Washington Society of Engineers, Washington Academy of Sciences, Washington Board of Trade, American Association of College Professors, Philosophical Society of Washington, American Geophysical Union, and the Cosmos Club.

EARL K. FISCHER, who died on August 3, 1951, had served as chief of the organic coatings section of the National Bureau of Standards for slightly less than a year prior to his death. His previous assignment had been as consultant to several divisions of the Bureau on problems in the field of rheology. Before coming to the Bureau in 1949, Dr. Fischer was head of the physical chemistry division of the Institute of Textile Technology at Charlottesville, Va. From 1933 to 1945 he was a physical chemist with the Interchemical Corporation. During the early part of this period he was with the United Color and Pigment Co., a subsidiary of the Interchemical Corporation; he later transferred to the central research laboratories and was head of Interchemical's physical-chemistry laboratory from 1939 to 1945.

He was born in Milwaukee, Wis., on November 21, 1905. He received a B.A. degree in 1927 and an M.A. in 1928 from the University of Southern California and the Ph.D. in 1931 from the University of Wisconsin. He held a Stieglitz fellowship in physical chemistry at the University of Chicago for three years.

Dr. Fischer was the author of a recently published book, *Colloidal dispersions*, and many technical papers that reflect his extensive investigations in the fields of surface chemistry, rheology, pigment technology, and the special instruments and techniques he developed in the course of these studies. He was a member of the American Chemical Society, a Fellow of the American Association for the Advancement of Science, and from 1947 to 1949 he was the Secretary of the Society of Rheology. He was also a member of the American Institute of Physics, Textile Research Institute, Fiber Society, New York Academy of Sciences, Washington Academy of Sciences, Virginia Academy of Science, Society of Motion Picture Engineers, American Association of Textile Chemists and Colorists, Sigma Xi, Phi Beta Kappa, Phi Lambda Upsilon, and the New York Chemists' Club.